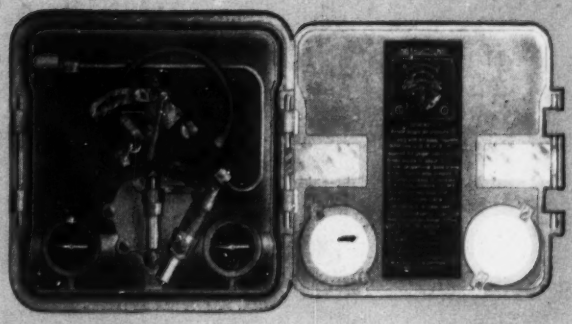
Instruments and AUTOMATION

Control room at new Santee-Cooper Power Station, Moncks Corner, South Carolina. (Photo courtesy Leeds & Northrup Company. For story see page 922.)

Vol. 27 · No. 6
JUNE · 1954

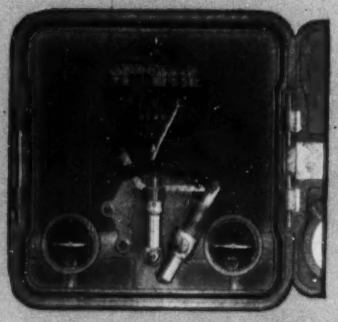
BS&B Announces:

. . . An Even Better Pressure Controller — Climax Type 1440



The Climax Type 1440 Pressure Controller (non-recording) is designed to handle both positive and negative pressures, from high vacuum to pressures of up to 10,000 lbs. Bourdon Tube actuated — with all tubes, bellows assemblies, feed orifices and bleed nozzles calibrated — the Type 1440 is an instrument of utmost accuracy. Proportional band and On-Off or Maximum-Minimum snap action adjustment is easily made without additional parts. Snap action may be adjusted to pressures up to 75% of the limits of the Bourdon Tube rating.

. . . An Even Better Liquid Level Controller Pilot . . . Climax Type 1450



The type 1450 Liquid Level Controller Pilot was developed for use and mounting on any Climax Type 888, 888-LF, 887 and 889 displacement liquid level controllers where a torsion tube transmits float movements to reflect changes in liquid level or a change in gravity of the controlled liquid. Its interchangeability of parts with those of the Type 1440 Pressure Controller is an advantage which reduces stocking parts.

Type 1450 features a very wide "throttling" range calibrated from 0% to 100%. A specific gravity index is provided and offers a method of compensating for various gravities of liquids, or for inter-face services, where the "throttling" range is kept exact in its relationship to the specific gravity setting.

A novel feature of the Type 1450 is its adjustability, without use of special parts, for "snap" or "on-off" action. This is useful when it becomes desirable for the diaphragm control valve to fully open or close when liquid level height reaches a desired "high" setting, and to react in an opposite manner at a desired "low" setting. The amount of liquid level change from open to shut positions of the control valve may be varied up to 75% of displacement element length.

Improved Features of Types 1440 and 1450:

1. Weatherproof case of die-cast aluminum designed for universal mounting.
2. Compact size — 8" x 8" x 4".
3. Door hinges to left or right, as desired.
4. Straight line piping.
5. Proportional bellows, calibrated, spring opposed.
6. Micro-adjusted set-point, graduated.
7. Molded diaphragms in power unit.
8. Easy parts replacement or assembly.
9. Feed orifice cleaner.
10. Snap action available over 10% to 75% of tube range without additional parts. (Applies to Type 1440 only.)
11. Pilot action reversible by moving a single link, without tools.
12. Elimination of superfluous linkages, resulting in easier adjustability and greater sensitivity.

Types 1440 and 1450 Have Been Developed and Thoroughly Field Tested for More Than Two Years!

Types 1440 and 1450 are but a small part of the complete Climax line—designed, engineered and precision manufactured by BS&B to meet your most exacting requirements. Send for your free copy of the complete Climax catalog!

For Better Process Controls . . . Always Specify BS&B Climax!

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Climax Controls Division, Dept. 4-V6

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For more information circle 1 on inquiry card.

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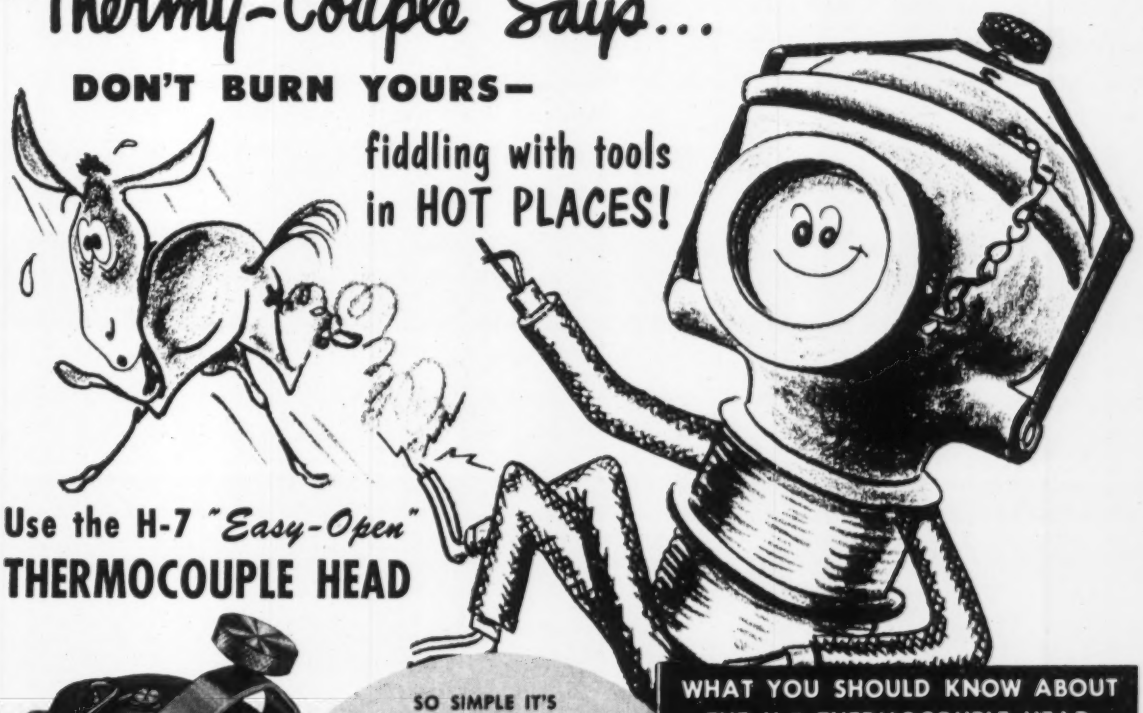
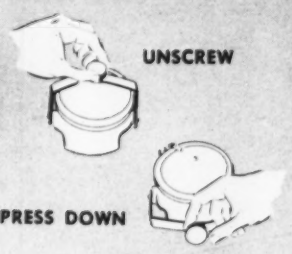
DON'T BURN YOURS—

fiddling with tools in HOT PLACES!



Use the H-7 "Easy-Open" THERMOCOUPLE HEAD

SO SIMPLE IT'S ELEMENTARY



NO WRENCH NEEDED ...NO RUSTY SCREWS TO REMOVE

The H-7 is an all-purpose thermocouple head that will accommodate *any size* wire whether base metal or platinum. It fits all standard protection tubes with threaded fittings, metal or porcelain.

Available in 1", ¾" or ½" standard pipe thread thermocouple openings. ¼" conduit lead wire opening.

Materials and Craftsmanship of highest quality ... and Our Prices are Lower!

WHAT YOU SHOULD KNOW ABOUT THE H-7 THERMOCOUPLE HEAD

- It is moisture-proof, rust-proof and non-corrosive.
- Gas tight and heat resistant.
- Light weight and compact.
- One-piece Thermocouple assembly *snaps out, snaps in.*
- Stainless steel cover—Cast aluminum base.
- Asbestos gasket (stays in place).
- Cover chained to base.
- Polarity marks plainly marked.
- Millions Now in use.
- This Super Head is lower in price than ordinary Heads.
- Immediate delivery, any quantity.
- Molded transite connector block.

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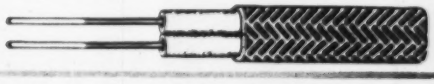
AND SUPPLY COMPANY

"For over a Quarter Century" ALTON, ILLINOIS

World's Largest ACTUAL MANUFACTURER OF PYROMETER AND THERMOCOUPLE EXTENSION LEAD WIRES.

Also Protecting Tubes and Insulators.



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Custom-built Quality in your

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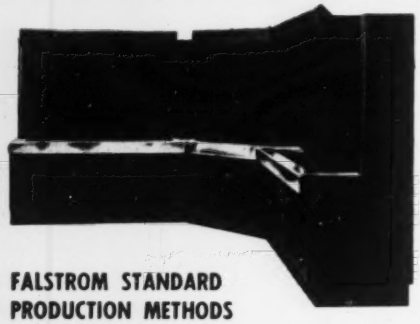

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Specifying FALSTROM for your metal products requirements means you obtain quality production with a maximum of economy. FALSTROM production techniques make use of stock tools and dies, standardized formed construction methods and standard detailed drawings wherever possible. For complete information on FALSTROM facilities, request new Bulletin 142; for a recommendation on a specific assembly, send blueprints or sketches – no obligation.

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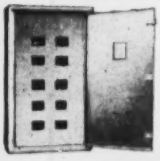

of Steel, Aluminum, Copper, Brass, Stainless Steel and other alloys.

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For more information circle **2** on inquiry card.

Instruments and AUTOMATION

Vol. 27 — June, 1954 — No. 6

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CORRECTION

A company name on the front cover illustration of the May, 1954 issue of *Instruments and Automation* was reported erroneously. The correct name of the company at which the graphic panel is located is the American Box Board Company. The illustration was provided by the Foxboro Company.

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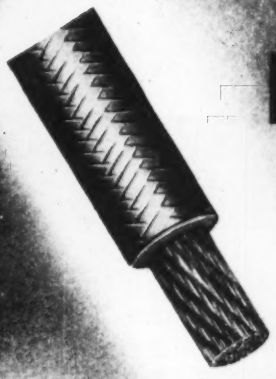
HIGH TEMPERATURE MOISTURE and FIRE RESISTANT ELECTRICAL CABLE *for AIRCRAFT*

LEWIS



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FOR SUPERIOR WET DIELECTRIC STRENGTH, ABRASION RESISTANCE, HIGH TEMPERATURE AND FIRE RESISTANCE, AS WELL AS RESISTANCE TO OIL, FUEL, HYDRAULIC FLUID AND SALT WATER —

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SPECIFY *LEWIS* MIL THERMOCOUPLE WIRE
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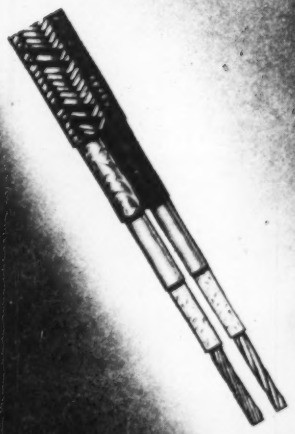
CORRECTLY CALIBRATED TO INSURE AIRCRAFT ACCURACY AND WITH LEWIS LAMINATED INSULATION TO MAINTAIN CIRCUIT INTEGRITY



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PRODUCED IN OUR OWN WIRE MILL, LEWIS THERMOCOUPLE WIRE AND LEWIS HIGH TEMPERATURE ELECTRICAL CABLE ARE BUILT TO MEET AND IN MANY CASES EXCEED, THE RIGID SPECIFICATION REQUIREMENTS.

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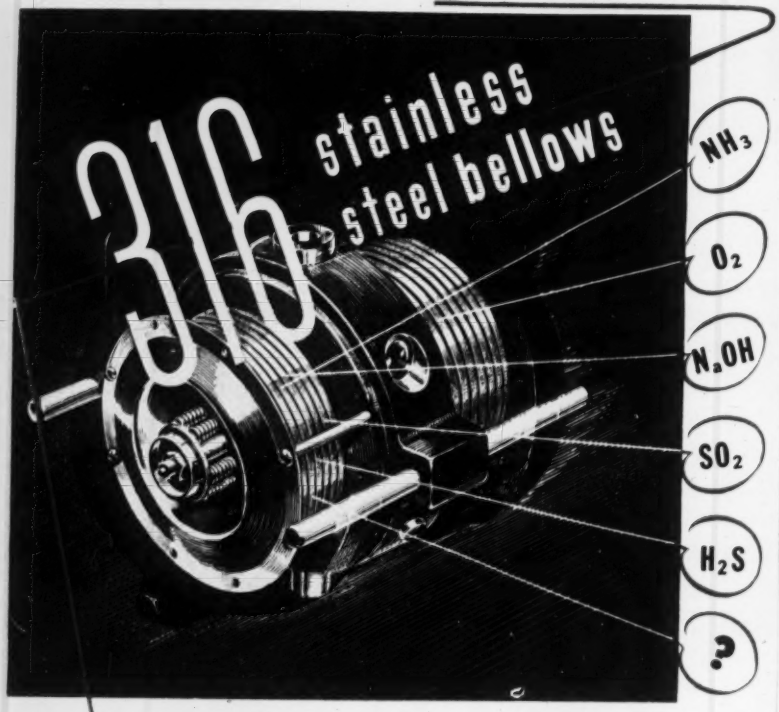

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Experienced sales engineers representing BARTON, are located in most principal cities. The Barton line is fully described in literature available upon request.

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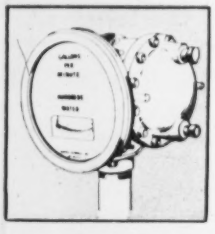

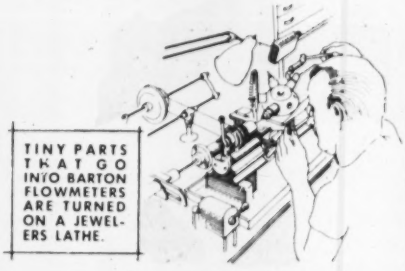

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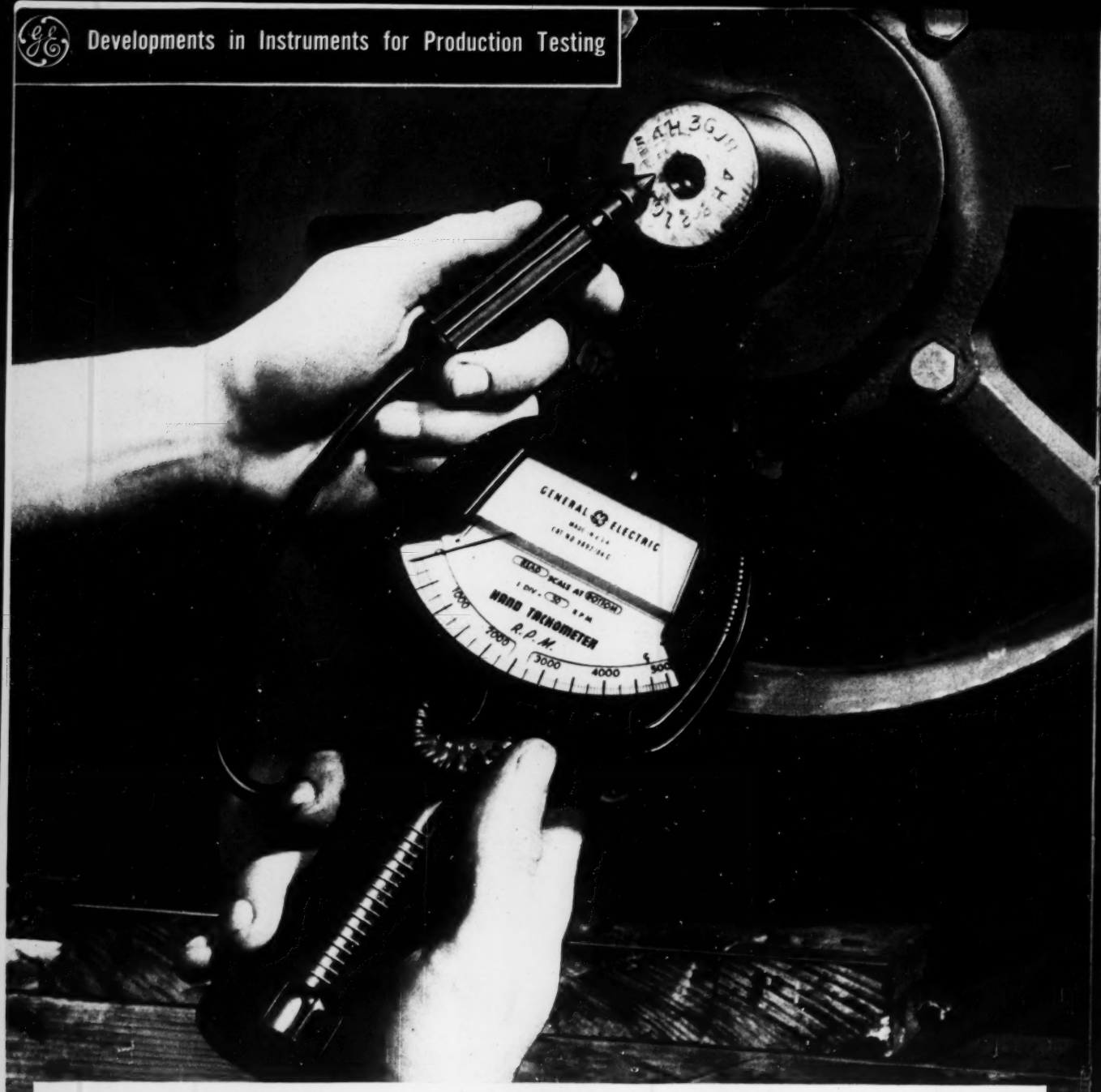


0–2000 SCALE

0–5000 SCALE

0–10,000 SCALE

NEW SCALE-CHANGING FEATURE of G-E hand tachometer eliminates errors that so often occur when reading a scale that has two or three sets of numbers. At any one setting of the control knob, *only one* of three sets of numbers is visible. A simple turn of the knob brings into view the 0–2000, 0–5000, or 0–10,000 scale, as shown above. Other models provide 0–1000, 0–2000, and 0–5000 scales; and 0–200, 0–500, and 0–1000 scales. High- and low-speed adapters increase the range of each of the scales by a factor of 10.

3-SCALE VERSATILITY—ACCURATE 1-SCALE READING . . .

NEW General Electric Hand Tachometer Cuts Costly Speed-measurement Errors

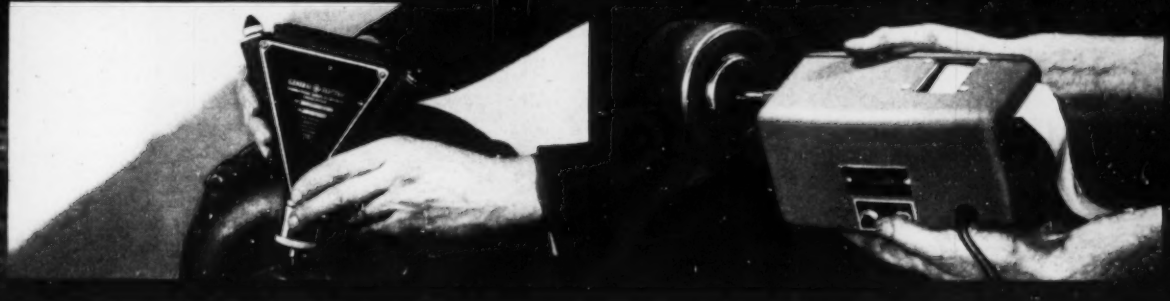
The new General Electric hand tachometer gives you quick, dependable speed measurements—measurements with minimized human error!

1. Because only one of three sets of scale numbers is visible at a time, you cannot read the wrong scale.
2. On all three scales, the number of rpm (or fpm) per scale division is clearly indicated.
3. Changing scales requires only a thumb-turn on the handy control knob.
4. Changing scales while in use cannot damage the instrument.
5. Overspeeding cannot damage the instrument.
6. Flexible connecting cable prevents vibrations from shaking the instrument.

Used with the proper accessories, the new tachometer provides a wide range of accurate speed measurement. It is ideal for measuring the rotational speeds of motors, generators, turbines, and engines; and linear speeds of conveyor belts, planer beds, shapers, band saws, and continuous webs. Price, complete with case and accessories, is $152.72*.

LIGHT-WEIGHT and well-balanced, General Electric's new hand tachometer is designed to give you steady, accurate speed readings every time.

HERE'S NEWS ABOUT G-E VIBRATION-TESTING INSTRUMENTS



LIGHT-BEAM VIBRATION INDICATOR locates immediately points of excessive machinery vibration. Available with either of two scales: 0–15 or 0–30 mils. Frequency response is 15 to 250 cycles per second. Price $195.00*.

RECORDING VIBROMETER measures and records frequency, displacement, and wave shape of mechanical vibration. Frequency range is 10 to 120 cps; amplitude, 5 to 125 mils with 0 to 20G acceleration. $265.00*.

*Manufacturer's suggested retail price.

See these and other G-E instruments at the American Society of Testing Materials Show, June 14–18, Hotel Sherman, Chicago, booths, 9 and 10.

SECTION B605-69, GENERAL ELECTRIC CO., SCHENECTADY, NEW YORK

Please send me the following bulletins:

- ☐ Hand Tachometer (GEC-241)
- ☐ Vibration-measuring Equipment (GEC-853)
- ☐ Measuring Equipment Catalog (GEC-1016), containing helpful facts about the complete line of G-E instruments.

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Company_____

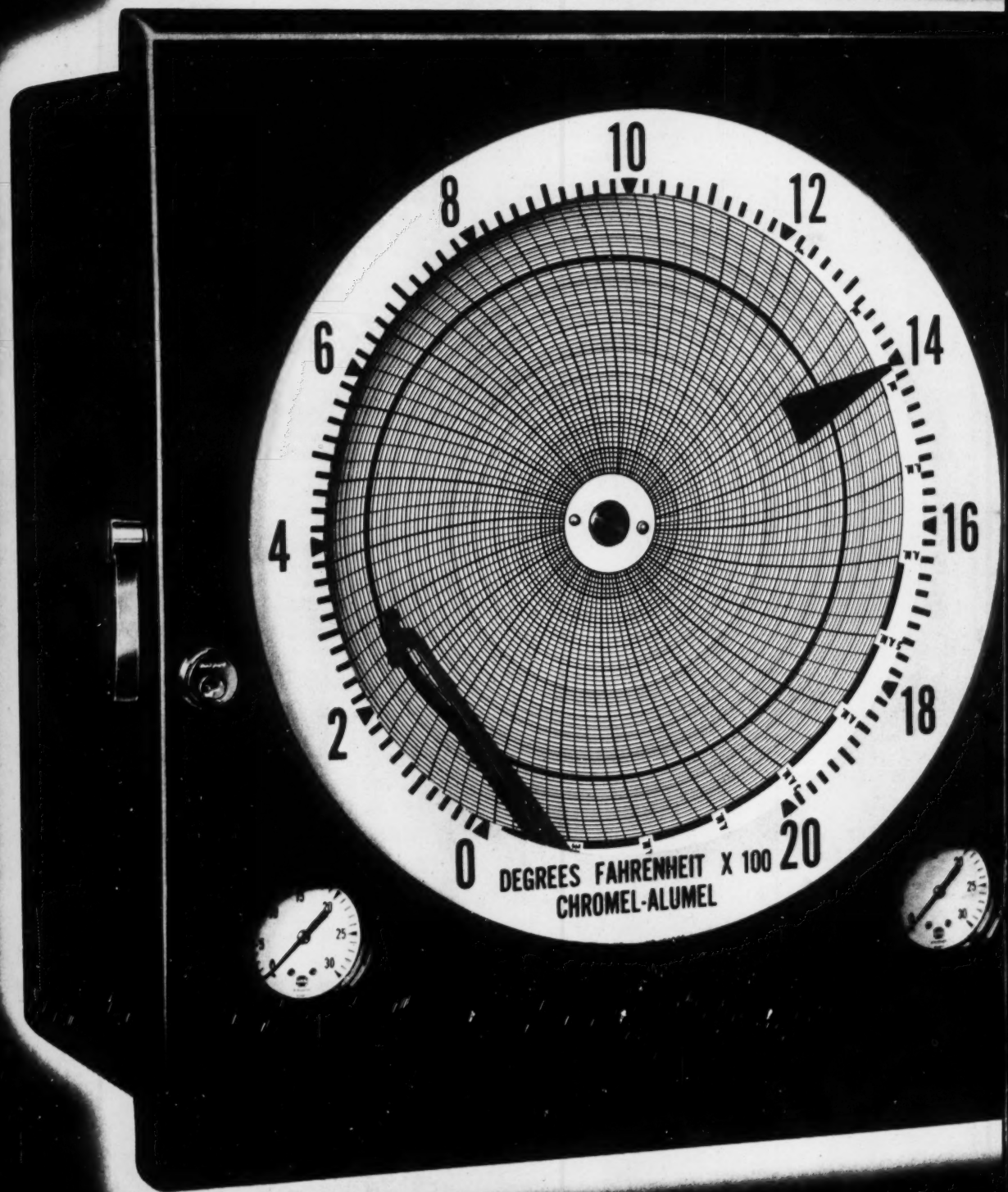
Street_____

City_____ Zone_____ State_____

GENERAL ELECTRIC

For more information circle **6** on inquiry card.

General Electric Announces

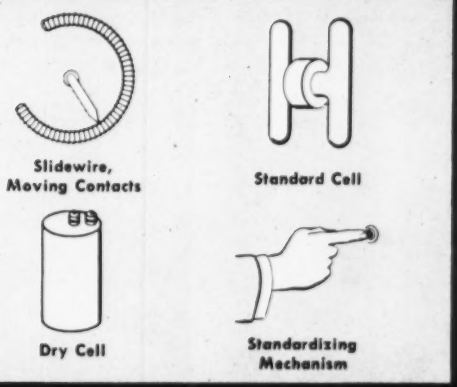


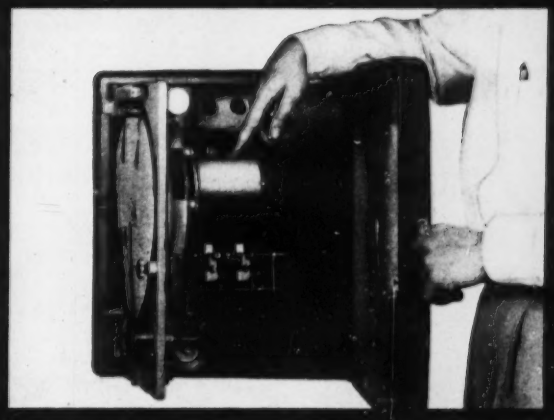
A New Recording Controller

REVOLUTIONARY MEASUREMENT-CIRCUIT DESIGN ELIMINATES MANY TROUBLESOME COMPONENTS

General Electric's new d-c recording controller assures you of having less maintenance by eliminating conventionally used dry cells, standard cells, slidewire and sliding contacts. Replacement costs for dry cells, or worn, corroded electrical contacts are gone, and your savings increase with the exacting control of this new instrument.

THE MAGNETIC STANDARD provides truly continuous standardization in new G-E recording controller and the measuring circuit incorporates the high stability of a permanent magnet for a reference standard. Loss of measurement and control can never be experienced, during standardization periods, with the constantly balancing G-E system. Your end-product quality, under the effects of increased accuracy and precision of measurement, will reflect even more cost and time savings in your operation.





By eliminating the above components, the new G-E potentiometric recording system reduces maintenance time (at no extra cost) and excludes such time-consuming jobs as replacing dry cells, or cleaning moving contacts.

Condensed size through unit construction makes the new Magnetic Standard easy to service. The controller has a maximum number of plug-in parts to facilitate range changing in the field. No unsoldering is required.

See this and other G-E instruments at the Instrument Society of America Show, September 15-21, Commercial Museum, Philadelphia, booths 531-537.

SECTION B602-276
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

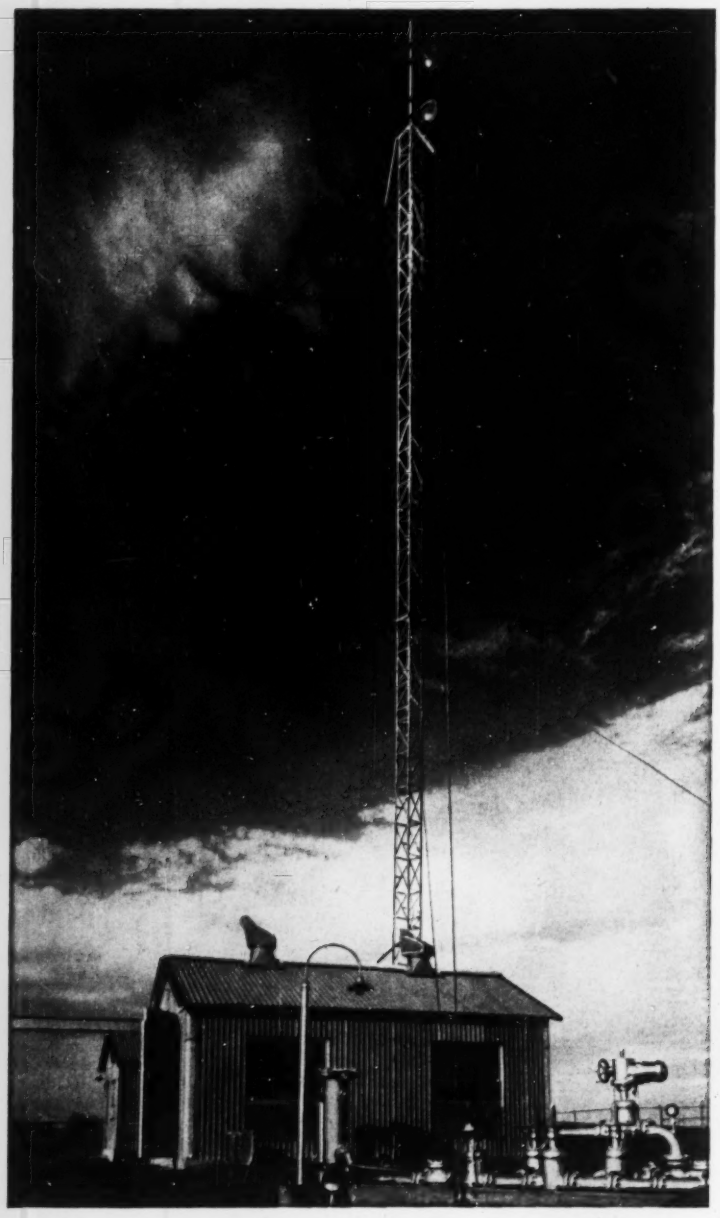
Please send me a free copy of the new bulletin, GED-2100, which features the New Recording Controller in a colorful, twenty-page picture story.

Name ..... Company .....
Street ..... City ..... State .....

GENERAL ELECTRIC

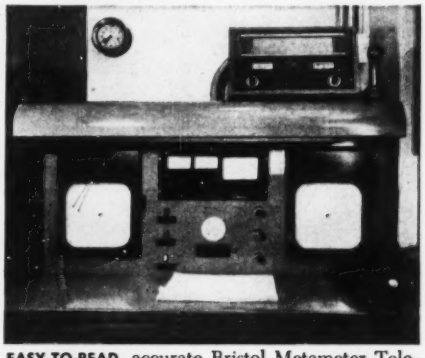
For more information circle 7 on inquiry card.

WHAT'S NEW AT BRISTOL . . . WHAT'S NEW AT BRISTOL



Nobody here but us instruments!

• Bristol Metameter Telemeters continuously record suction and discharge pressures and kilowatt hours used by electric motors at Sunray Oil Corporation's completely unattended, radio-controlled pumping station in Pernell, Oklahoma. Readings are transmitted by microwave radio from this and another Bristol-equipped booster station at Ada, Oklahoma, to Sunray Oil's Wynnewood control station, 25 miles away. These radio-controlled booster stations, the first of their kind, increased Sunray Oil's products pipe line capacity by 25 per cent.



EASY-TO-READ, accurate Bristol Metameter Telemeter receivers at the Wynnewood control station provide a continuous record of performance at booster stations 24 hours a day.

Find out how Bristol Metameter Telemeters can help *you* – write for free 40-page booklet M1710. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle 8 on inquiry card.

Trends...

Instruments and AUTOMATION

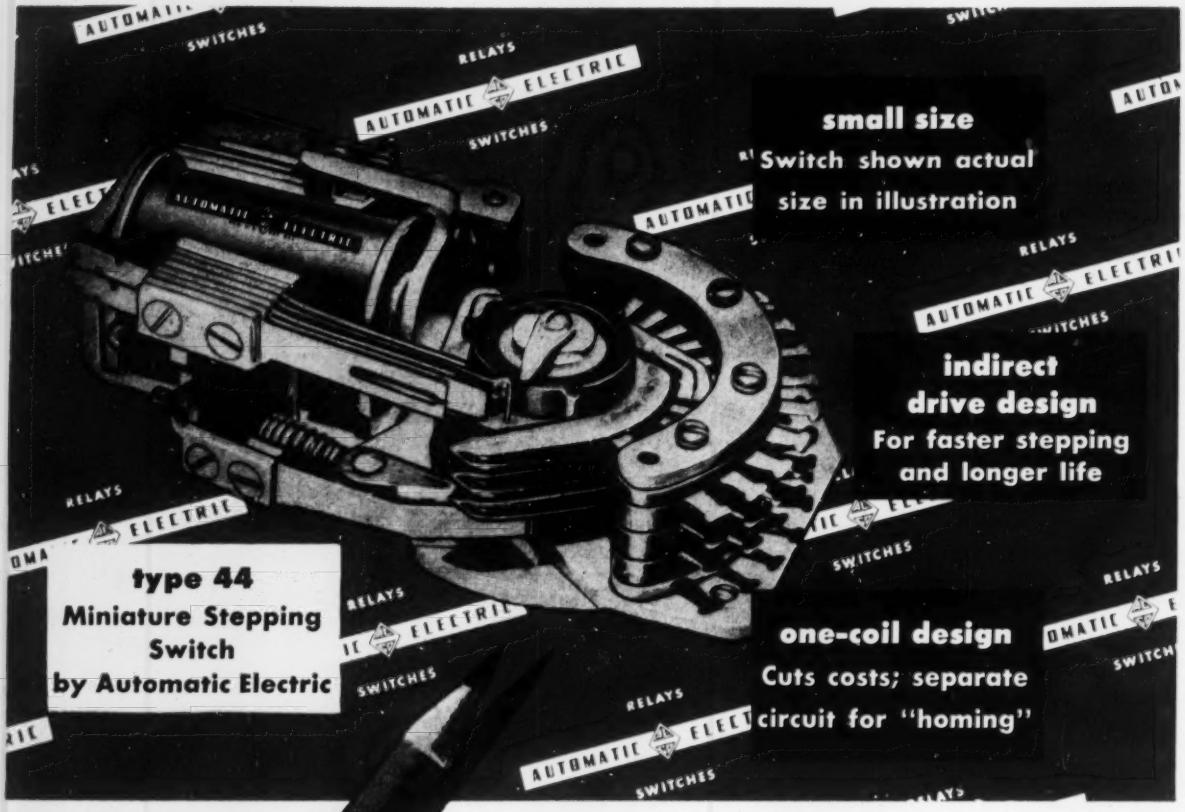
Outstanding trend is tremendous gain in use of radiation devices, particularly X-ray. Wall Street Journal reports that in 15 years the number of plants using X-ray equipment has increased from less than 500 to more than 4000. Prediction is that number will increase 500% in next 10 to 15 years. Reason: X-rays can detect flaws, be used in automatic factories, promote chemical changes, speed up research in materials, halt food and drug spoilage.

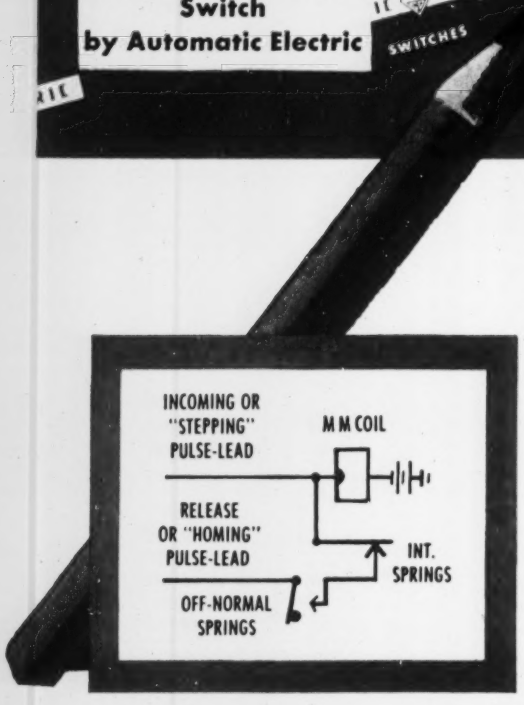
Low-temperature research is beginning to pay off industrially. Liquid helium is being used to ship and store liquified oxygen, argon, nitrogen, air, hydrogen. Lighter containers can be used, and gases can be kept free from contaminants. Natural gas can be upgraded by liquifying gas and then venting off the nitrogen, leaving larger proportion of combustibles for transportation and use. Other uses: refrigerated traps for vacuum work, reducing thermal-agitation noise in circuits.

Chemical industry, growing 10% annually compared with 3% for all industry, may be first industry to automatize its products completely, says C. W. Bowden, Jr., chemical industry manager for Minneapolis-Honeywell's Industrial Div.

Industry News: Servomechanisms, Inc., reports 1953 net sales at a new high of $13,332,746—an increase of 30% over the previous year.—K. B. Neff, Pres. of Exact Weight Scale Co., announces plans for expansion.—Indiana Steel Products reports a new sales record for 1953 and an increase in net earnings from $306,565 in 1952 to $335,925 in 1953.—Leeds & Northrup announces plans for a 250,000-sq.-ft. $4-million plant for North Wales, Pa.—Struthers-Dunn occupies new 54,000-sq.-ft. plant.—Precision Apparatus Co. will occupy new plant in Glendale, L. I.—Cinema Engineering opens new plant in Burbank, Calif.—The Burroughs Corp. occupies a new $3-million research center at Paoli, Pa.—Neptune Meter acquires Cox and Stevens Aircraft Corp.—Ketay Mfg. Corp. completes new 43,000-sq.-ft. plant at Commack, L. I.—Wilrite Products of Cleveland is new resistor firm.—Robertshaw-Fulton opens new 70,000-sq.-ft. plant at Indiana, Pa.—Taylor Instrument Cos. of Canada opens new 40,000-sq.-ft. plant in Toronto.—Foxboro announces new branch factories at San Leandro, Calif., Pittsburgh, Pa., and Dallas, Texas.—Total sales of Hagan Corp. for 1953 were $17,497,630 with earnings of $2.40 per share, compared with $15,949,428 and $2.21 in 1952.—Bogue Electric opens new plant at Paterson, N. J.—C. P. Clare & Co. opens new plant at Chicago.—Annin Co. occupies new 30,000-sq.-ft. plant in Los Angeles.—Consolidated Engineering Corp. forecasts that sales will top all records in 1954.

Air traffic control is subject of much research and development. Computers are finding application in air traffic control; new "Volscan" system developed by Air Force Cambridge Research Center can land aircraft at a rate of 120 per hour, one aircraft every 30 seconds. Tape-recorded preselected flight plans are being used to operate autopilots in new Automatic Sequence Selecter developed by Minneapolis-Honeywell with Wright ADC. New Ford Instrument A-1 dead-reckoning computer continuously indicates aircraft position in terms of latitude and longitude.





How separate "homing" circuit is provided with one-coil operation

Interrupter contact springs open coil circuit near the end of each armature operation—causing switch to step by self-interruption, or by "door buzzer" action.

"Off-normal" contact springs close "homing" circuit on first step of wipers off home position and remain closed until home position is again reached. Thus, after the first step, a "homing" circuit is prepared, and the switch may be "homed" by simply energizing this circuit.

How to make a good product better...without increasing costs

Design engineers everywhere are choosing Automatic Electric's Type 44 Miniature Stepping Switch to insure long service life—often *reducing* costs as they do so! In countless applications, this sturdy switch has operated for more than 200 million operations, with little or no adjustment. The one-coil design eliminates a separate release coil—a saving passed on to the user.

And there are other reasons for such widespread approval: weight and space are saved; indirect drive design give smooth stepping and because there's no wiper "double loading" there's no "galloping"; the unique driving mechanism permits extremely high operating speeds.

Investigate Automatic Electric's Type 44 Switch for your control applications. Here's the first compact, lightweight switch to provide 10-, 20- or 30-point operations. Designed for any dc voltage up to 110, or, with an associated rectifier, for 115 volts 60 cycle ac. For more details on this and other Automatic Electric stepping switches, write for helpful engineering specifications to: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

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For more information circle 9 on inquiry card.

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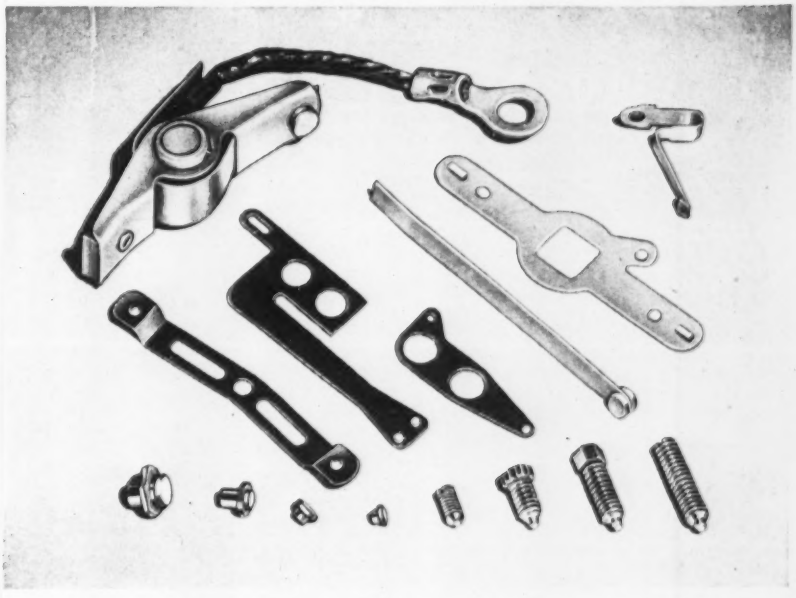
precious-metal contacts

for assured performance in your product



IF YOU use precious metal contacts in your equipment, it will pay you to get acquainted with what Mallory can do for you. Mallory contacts have earned a reputation, among leading manufacturers of electrical and electronic products, for being expertly designed . . . precision manufactured . . . and economically priced for the intended use. Here are some of the reasons behind this reputation:

VARIETY OF MATERIALS: includes the Elkonium® family of platinum and palladium alloys; Mallory fine silver, coin silver; and Silver Elkonium alloys of copper, gold, platinum and palladium . . . all products of Mallory's extensive metallurgical research.

FABRICATION TECHNIQUES: specialized methods developed by Mallory for brazing, welding and direct bonding permit maximum economy of costly metals, and assure good contact life.

ECONOMICAL ASSEMBLY: many manufacturers have found that by utilizing Mallory's facilities for producing complete contact assemblies, they can reduce overall costs and eliminate the uncertainties and re-shipment problems that come with divided responsibility.

Mallory also offers parallel facilities and a full selection of contacts for heavy-duty and other applications beyond the scope of precious metals.

New Catalog Available

A 60-page catalog, "Mallory Contacts and Contact Assemblies," describes the many types of Mallory contact materials and assemblies . . . includes valuable selection data and design information. Write for your copy today.

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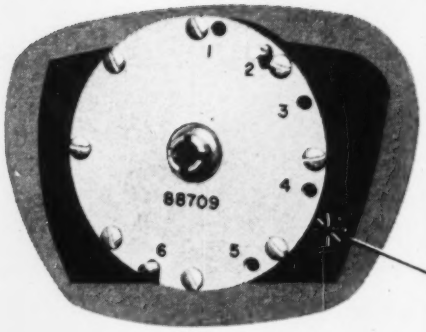
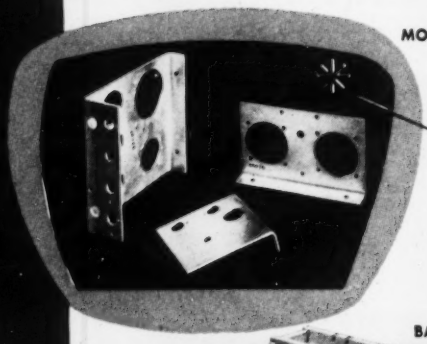
LINK AVIATION

Hi-Precision

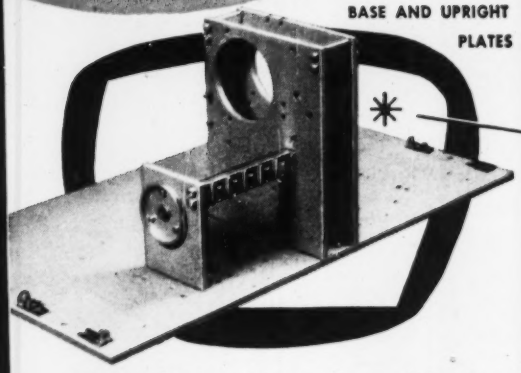
FRICTION CLUTCHES



MOUNTING BRACKETS



BASE AND UPRIGHT PLATES



★ Link bridges the gap between laboratory and production with a completely new approach to component design. So skilfully are the servo parts correlated, so precisely are they produced, that the same units—mechanical and electronic—can be used interchangeably in laboratory prototypes and actual production models. This new technique assures in-use performance during research—cuts costs in production design—saves time in tooling-up for new models in the fast-changing electronics field.

Manufacturers of the world-famous Link Trainers • fractional h.p. wide range variable speed drives • friction and over-drive clutches • ratio voltmeters • precision potentiometers

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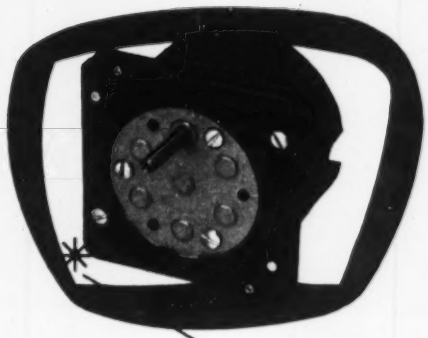
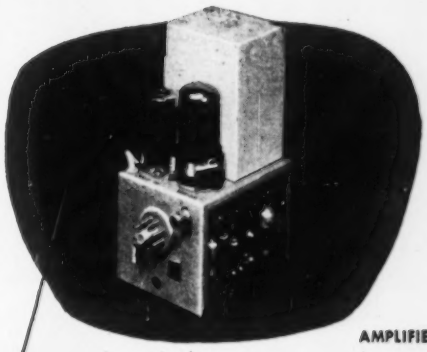
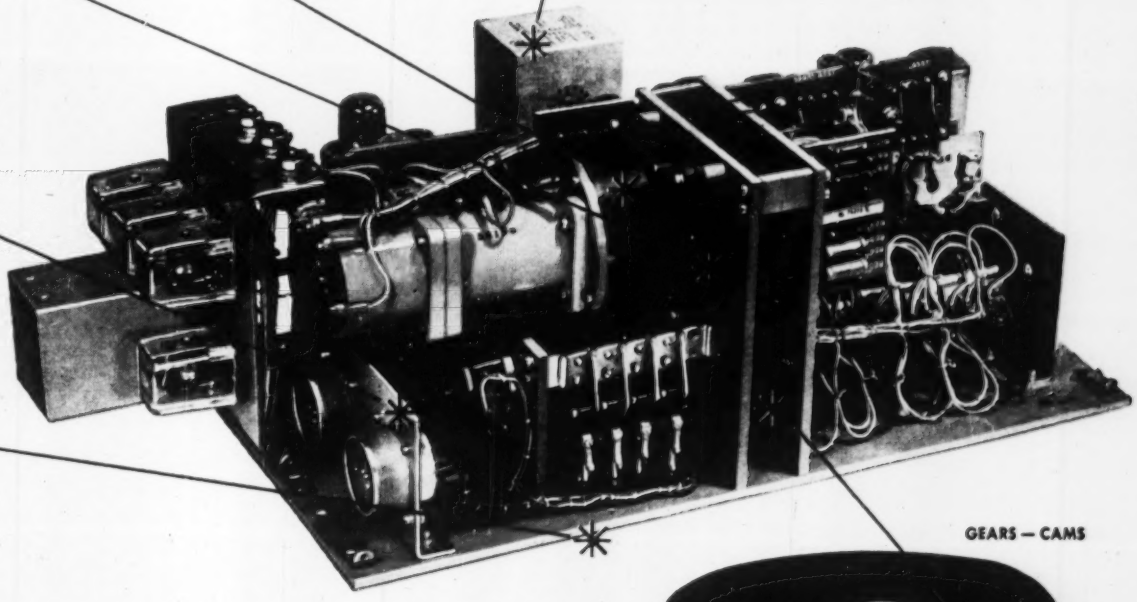


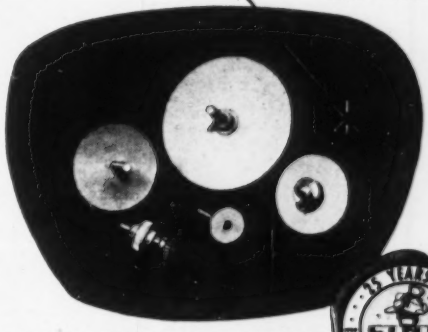
GEAR BOXES



AMPLIFIERS — PHASE DETECTORS



GEARS — CAMS



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★ *Hi-Precision* manufacturing standards that assure accurate servo operations. All mechanical units are held to close tolerance.

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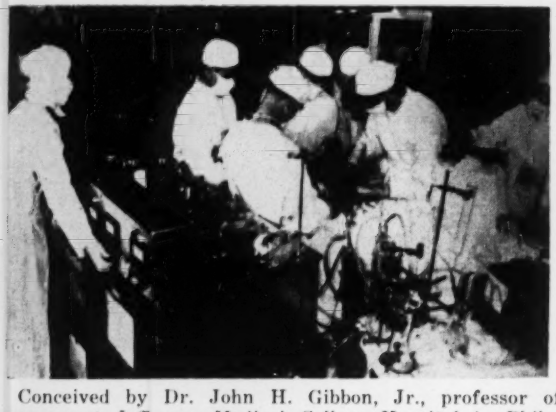
INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

Automatic Heart

PHILA., PA.—An electrically powered man-made heart, about the size and shape of a spinet piano, recently made medical history. The machine—actually a mechanical heart-lung combination—was used for the first time to save a patient's life during delicate heart surgery. The large instrument performed the work of the patient's heart and lungs for 26 minutes while surgeons repaired the empty heart.



Conceived by Dr. John H. Gibbon, Jr., professor of surgery at Jefferson Medical College Hospital in Philadelphia, the mechanical heart-lung had previously been used successfully on dogs. "Heart" of Dr. Gibbon's artificial heart are four electronic controlling recorder-controllers developed by Minneapolis-Honeywell's Industrial Division, which balance the flow of oxygen and carbon dioxide and regulate the blood supply. On top of the metal ledge of the machine, corresponding to the keyboard of a piano, there are four circular devices. On each there is a single coil of plastic tubing strung in an arc around a movable metal roller. They simulate the heart.

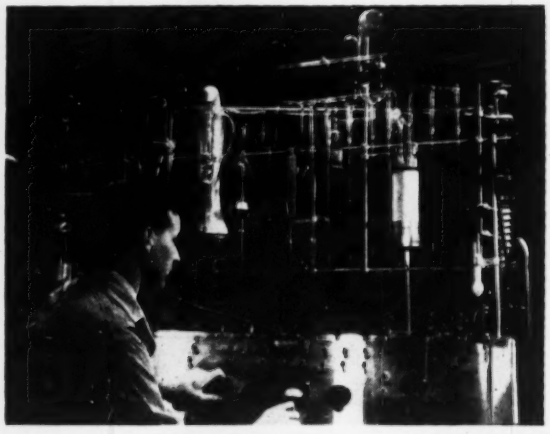
The patient's blood passes through the first three coils, being squeezed along by the rollers. Then it falls on an upright plastic sandwich, which resembles an old-style washboard. Inside the plastic sandwich there are six crinkled thin-wire screens. The blood flows down the screens in a fine film, being rippled enough to absorb oxygen that is gently blown across the screen. As the oxygen removes the carbon dioxide from the blood, the purified blood turns from purple to red as it flows down the screen. The plastic sandwich does the work of the human lung. The blood then flows into the fourth and last coil where the final roller squeezes the liquid back into the patient's arteries. The device is expected to "open new vistas in the field of heart surgery."

Infrared Spectroscopy

CAMBRIDGE, MASS.—Two one-week special summer programs in infrared spectroscopy will be offered during the 1954 Summer Session at the Massachusetts Institute of Technology—(1) Technique of Infrared Spectroscopy, July 19 through July 23; and (2) Applications of Infrared Spectroscopy, July 26 through July 30. Details are available from Summer Session Office, Room 7-103, M. I. T., Cambridge 39, Mass.

Gas Content of Metal

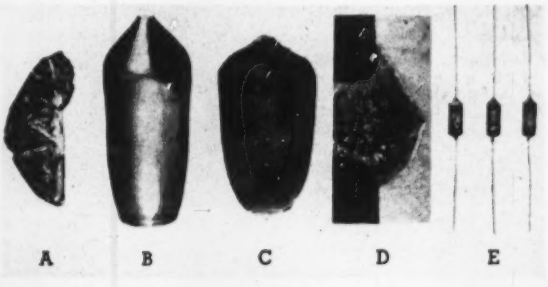
CINCINNATI, OHIO.—Engineers at the General Electric Company's Aircraft Gas Turbine Division Laboratories use a Vacuum Fusion Gas Analyzer to determine the exact amount of oxygen, hydrogen, and nitrogen in various metals and alloys. The analyzer is manufactured by the equipment division of the National Research Corp. of Cambridge, Mass.



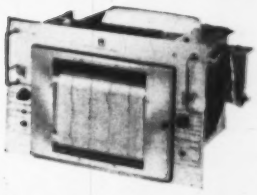
The gas content of a metal affects its strength. This is particularly true of titanium, the new light alloy. The metal under test is first heated in a small furnace to temperatures as high as 2400 degrees Centigrade to release the gases. The gases, caught in the glass tubing, circulate to a collection bulb where the engineer determines the smallest residues of gas and then separates each gas for further analysis. The apparatus can determine if there are 10 parts of a gas per million within accuracy of plus or minus 10 percent of the amount present.

Silicon Diode Evolution

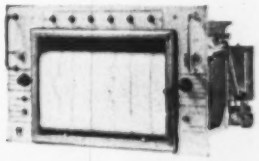
DALLAS, TEXAS.—Evolution of silicon diodes is shown in this photo-story prepared by Texas Instruments, Inc., 6000 Lemmon Ave., Dallas, Texas. A. Polycrystalline silicon commonly used for point-contact silicon diodes. B. Newly developed grown single crystal of high-purity silicon. C. Sectioned single crystal showing homogenous structure (contrast with A). D. Photomicrograph of new TI silicon diode showing semiconductor alloyed junction. E. Production silicon-junction diodes complete with glass-to-metal



ONE DESIGN
MEETS **MANY** REQUIREMENTS →

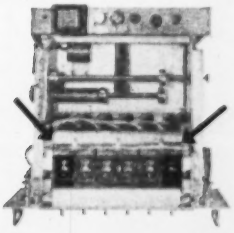


4 CHANNELS

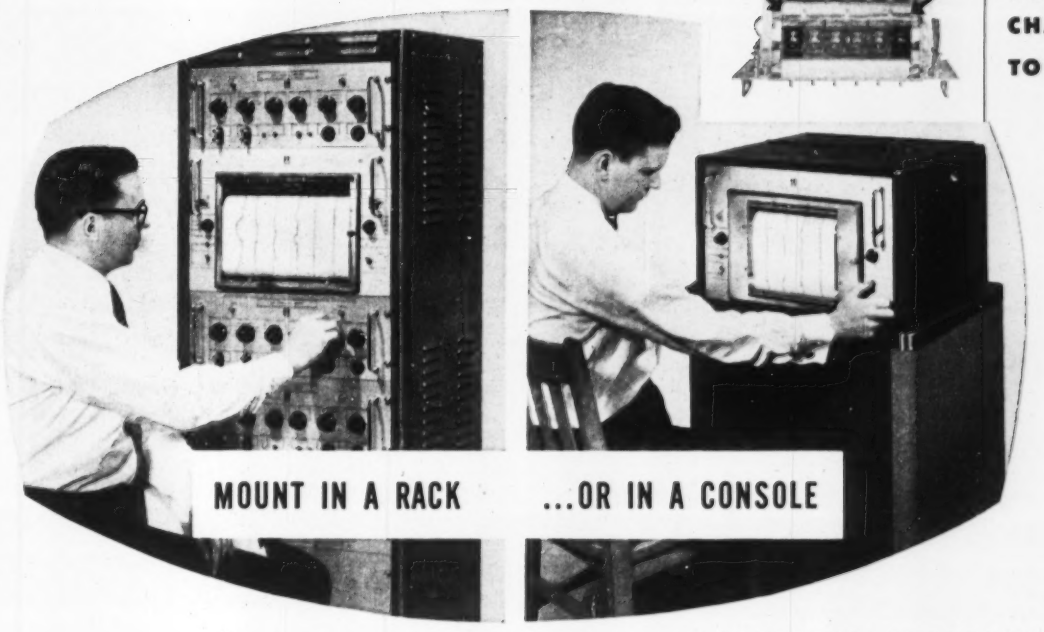


OR 6

NEW BRUSH OSCILLOGRAPHS



OR EXPAND YOUR 4 CHANNELS TO 6



Standardized design of these new Brush multi-channel oscillographs permits greater flexibility in instrumentation. An identical chassis which can be installed in either a standard 19-inch rack or a console is used for both 4 and 6-channel units. The new electrically-controlled chart drive provides up to sixteen speeds for greater flexibility of speed and operation. The chart can be driven as slow as 1 cm/hour or as fast as 250 mm/sec.—the highest chart speed available on any standard oscillograph. The units can be equipped for local or remote control. Get all the facts—send the coupon today, or call your Brush representative. Brush Electronics Company, Cleveland 14, Ohio. In Canada: A. C. Wickman, Ltd., Toronto.

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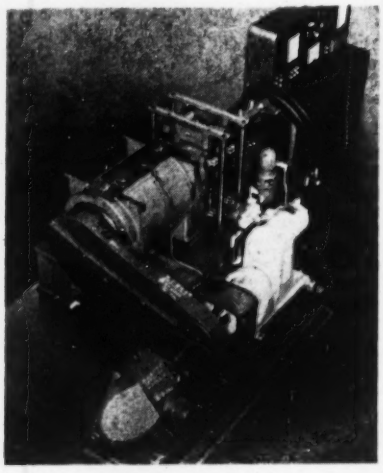
ON THE MARCH—CONTINUED

hermetic sealing, featuring front-to-back current ratios as high as 10^7 and operation to 150 deg. C.

Railroad Bearing Tester

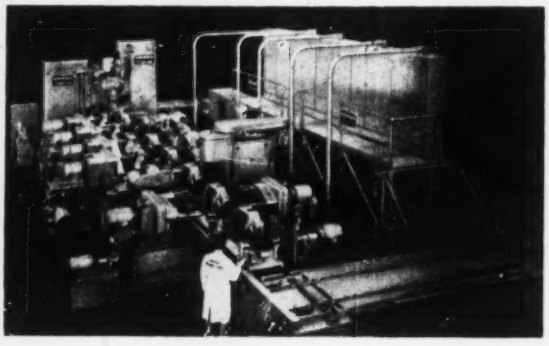
GREENWICH, CONN.—Higher speeds and longer runs of diesel powered freight trains are giving the railroads an unexpected and urgent problem; more hot boxes are demanding investigation of bearings and their lubrication.



An important aid is a specially developed testing machine recently completed by Sonntag Scientific Corporation, Greenwich, Conn., a division of Baldwin-Lima-Hamilton Corp. This machine is reported to be the first that can effectively reproduce most of the conditions of loading and wear on freight car journal bearings in actual service.

Machine-tool Automation

CLEVELAND, OHIO.—A new special machine tool of the "Transfer-matic" type for milling, drilling and tapping 2-speed truck axle carriers has been announced by The Cross Company, Detroit 7, Michigan, and delivered to the Axle Division of Eaton Manufacturing Company, Cleveland. With capacity for both spiral-bevel and hypoid-type carriers, the new machine processes 53 parts per hour. There are 9 stations, 1 each for loading and unloading and 7 for machining. A total of 97 operations are performed: 60 drilling, chamfering and reaming; 5 milling; 4 spotfacing and counterboring; 28 tapping. Two-position, progressive-type work-holding fixtures are transferred automatically from station to station; the fixtures are automatically returned from the unloading to the loading station by conveyor.



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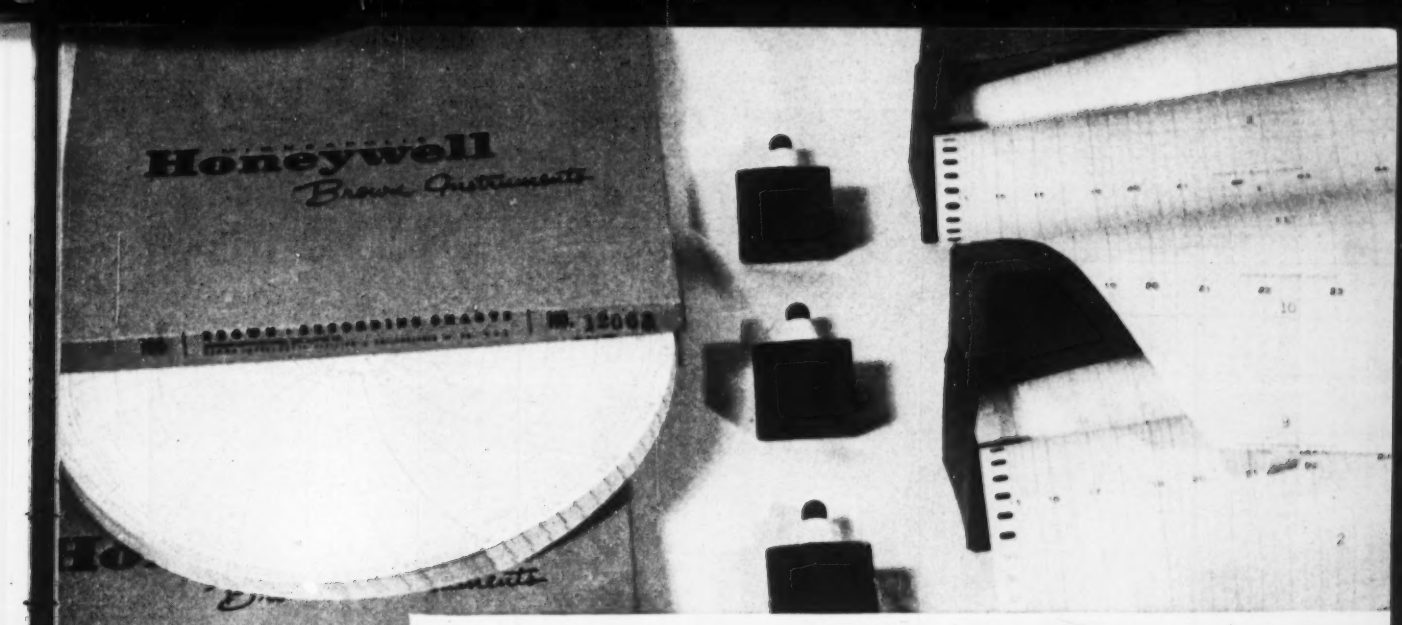

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Ask your local Honeywell Supplies Man about these new papers and inks . . . and about the economical, convenient HSM Plan for purchasing pyrometer supplies. Call him today . . . he's as near as your phone.

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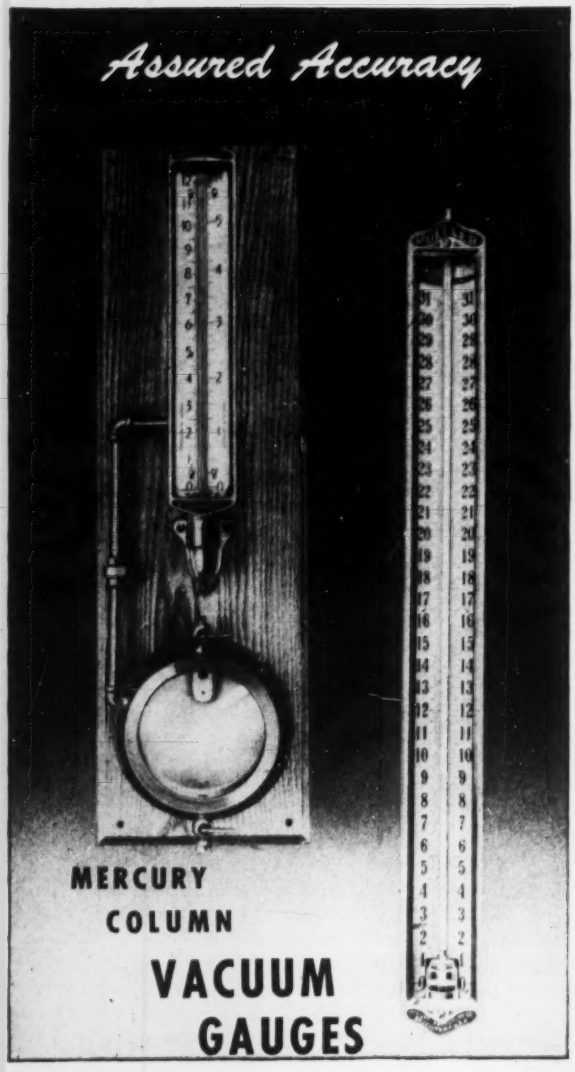

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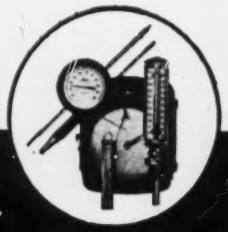

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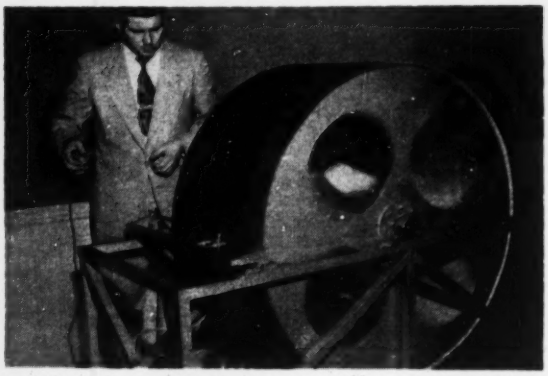
ON THE MARCH—CONTINUED

Four-foot Memory Drum

REDONDO BEACH, CALIF.—The "air-floating" four-foot metal-drum computer memory of Logistics Research Inc., Redondo Beach, Calif., is said to have a memory capac-



ity 200 times greater than conventional magnetic drums. The reading and writing head rests against the surface of the high-speed drum, lubricated by a film of air. The head can move over the surface of the drum, and the drum need not be precision made, making possible drums of any size.

Improved "Atomic Battery"

PORT HURON, MICH.—The "atomic battery," developed and produced four years ago by the Ohmart Corporation of Cincinnati, Ohio, has been improved by use of "Aquadag" as a positive electrode. The atomic battery, or Ohmart Cell, has been used for years in various industrial (temperature, specific gravity, pressure, etc.) instruments made by the Ohmart Corporation. It can now deliver enough current to run a tiny electric motor for possibly 20,000 years.

It has been found that a cell with electrodes of lead and gold—far apart on the scale of the electromotive series—delivered a current when the air surrounding them was exposed to radiation from as little as 25 millicuries of radium. "Aquadag" has proved to be more suitable as the positive electrode. "Aquadag" is used also to treat the surfaces of Ohmart's instruments to eliminate contact-potential or other stray currents. "Aquadag" is made by Acheson Colloids, Port Huron, Mich.

Power Cost Computer

BIRMINGHAM, ALA.—A new electronic computer which automatically calculates the cost of power delivered by

K & M introduced the molded diaphragm ...WHY?

Unlike many conventional control valve diaphragms, K & M contour molded diaphragms maintain a *constant effective area* throughout the entire range of valve stem travel. Control variations are transmitted to the K & M inner valve without distortion for more accurate, more reliable flow regulation. And, with less possibility of any binding and sticking whatsoever.

Furthermore, the effective area of the K & M contour molded diaphragm is particularly large. This greater area, combined with long stem travel, enables K & M Diaphragm Motors to provide virtually the highest "power factor" available. Thus, not only is the inner valve positioned more accurately, but sensitivity of response is also increased.

To assure long term service under the toughest operating conditions, all K & M diaphragms are molded of tough, inert neoprene and fabric reinforced.

In addition to contour molded diaphragms, K & M Control Valves incorporate other unique operating advantages, such as all steel topworks construction with open-yoke design, and the two-bolt patented continuous seal method for positive diaphragm casing closure.

WRITE FOR YOUR COPY of the new K & M Valve Engineering Data Catalog, Bulletin CV53.
NEW . . . Valve Size Slide Rule Calculator with **LOW FLOW DATA.**
Available upon request.

KIELEY & MUELLER, INC. diaphragm control valves

K&M

64 Genung Street
Middletown, New York

Valve Makers
Since 1879

For more information circle **16** on inquiry card.

YOUR POTENTIOMETRIC INSTRUMENTS

HAVE A HEART TOO!

NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
"As Standard as Sterling"

For more information circle 17 on inquiry card.

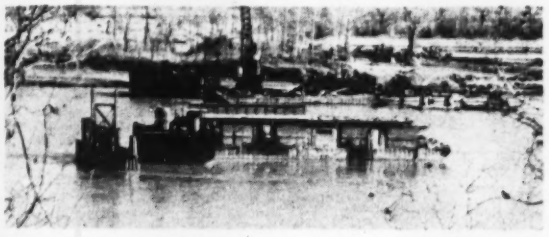
ON THE MARCH—CONTINUED

each station in the complex Southern Company System is being installed in the company's power supply coordinating station here. The computer, the first of its kind ever built, was designed and manufactured by Leeds & Northrup Company, Philadelphia.

After fuel costs at each station have been set on the computer, the electronic brain takes into account transmission losses and generating costs in arriving at the ultimate cost of delivered power. Nicknamed "Early Bird," after E. D. Early, manager of the Southern Power Company pool, who conceived the idea, the computer is unique in that it uses actual generation values that exist at any instant as provided by telemeters. Hence the cost of power delivered from any particular generating station is based on actual operating conditions.

Caisson Monitor

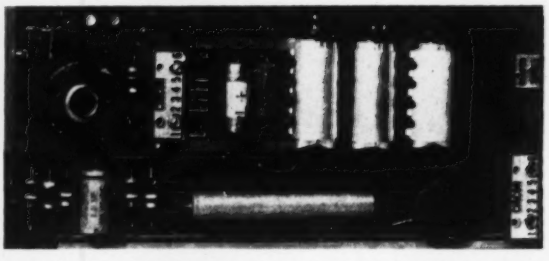
LEAVENWORTH, KAN.—Mid-stream in the Missouri River at Leavenworth is a powerhouse barge used by the



Kansas City Bridge Company to supply compressed air to the pneumatic caisson (left of the barge). MSA carbon-monoxide alarms detect and warn of the presence of carbon monoxide in compressed air being supplied to the caissons.

Printed-circuit Connectors

NORTHRIDGE, CALIF.—Printed oscillator, amplifier and coding circuitry plugs in to printed integrating and interconnecting channel running in opposite plane at the rear. Top Circon connector at right connects to power busses and



filter circuits. Lower connector at right handles complex input and output interconnection. A printed frequency-determining subassembly plugs into the main assembly in the same plane at the upper left hand corner via an edge-mounted Circon connector. Printed-circuit connectors are made by Circon Component Co., 17544 Raymer St., Northridge, Calif.

Tracers in Advertising

PITTSBURGH, PA.—A Pittsburgh firm—Calgon, Inc.—probably is the first to use radioactive-tracer technique to back up product claims in its advertising. Calgon, maker of a packaged household water conditioner, recently began showing "atomic laundering tests" in a filmed commercial

CEC Model 21-401
dual purpose mass spectrometer
combines:

Quantitative analysis

Inorganic gases	Research Centers
Hydrocabons	University Laboratories
Aliphatic derivatives	Oil Refineries
Aromatics	Petro-Chemistry
Water	Process Control
	Natural Gas
	Synthetic Fibers

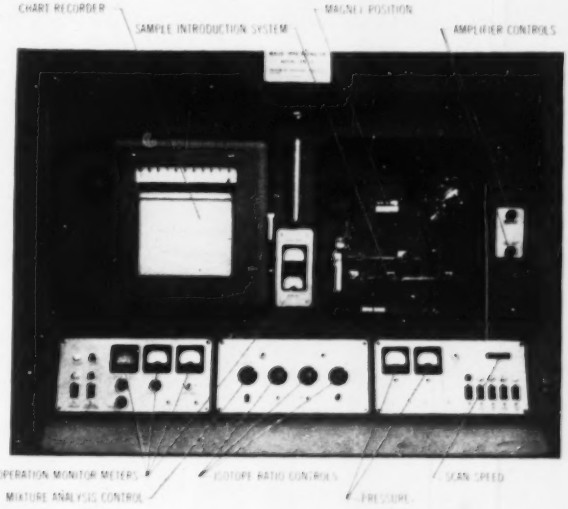
Simple or complex mixtures of gases and light liquids are analyzed qualitatively or quantitatively for Mol % abundance of each constituent in the mixture. The mass range extends from mass 2 to mass 100. Offers advantages of speed, accuracy, and versatility over other methods.

Isotope ratio recording

C^{13}	Biochemistry
N^{15}	Nutrition
O^{18}	Medical
S^{34}	Botany
Deuterium	Geology
	Inorganic Chemistry
	Organic Chemistry
	Catalysis

Stable isotope tracer techniques involving C^{13}, N^{15}, O^{18}, S^{34}, Deuterium, where a gas, light-liquid, or water is assayed for relative abundance of specific isotope with respect to a standard abundance sample. Makes the rare isotope a practical tool for analyses or mechanism investigations.

Quantitative analysis of gaseous or light-liquid mixtures, automatically recorded as mass spectra, is the primary function of the Consolidated Model 21-401 Analytical and Isotope-Ratio Mass Spectrometer. Its analytical range allows it to operate up through the C^7 Hydrocarbon group, making it a useful analytical instrument for gas, utilities, petroleum processing and chemical manufacturing companies. Precision recording of stable isotope ratios gives this versatile dual-purpose mass spectrometer operating flexibility and fits it for use in laboratories having isotope-ratio analysis problems. Moderately priced and economical to operate, the Consolidated Model 21-401 Mass Spectrometer is a practical tool for both industrial and scientific applications. Write for Bulletin CEC 1821-X2.



Consolidated Engineering CORPORATION — ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

300 North Sierra Madre Villa, Pasadena 15, California • *Sales and Service through* **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, Atlanta, Chicago, Dallas, Detroit, New York, Philadelphia, Washington, D. C.*

For more information circle **18** on inquiry card.

over a CBS coast-to-coast network. A Geiger counter kept score. Test piles of towels were soiled identically, with tiny amounts of radioactive material added as a tracer for the soil. Each pile of towels then was washed identically—same water, same machine, same amount of time for washing and rinsing. Well-known (but unnamed) soap and detergent products were used in turn, with and without the water-conditioning powder. Officials of Calgon were delighted not only with results—up to 50-percent improvement in washing and rinsing when the water conditioner was used along with the soap or detergent—but also in the fact that the "hot tracer" made it possible for the first time to prove product claims simply, dramatically and in a manner well-timed for the atomic age.

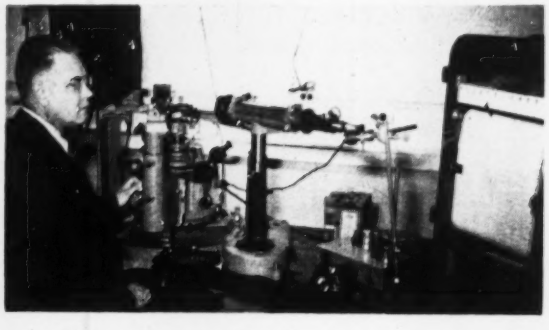
Jet-engine Check-out

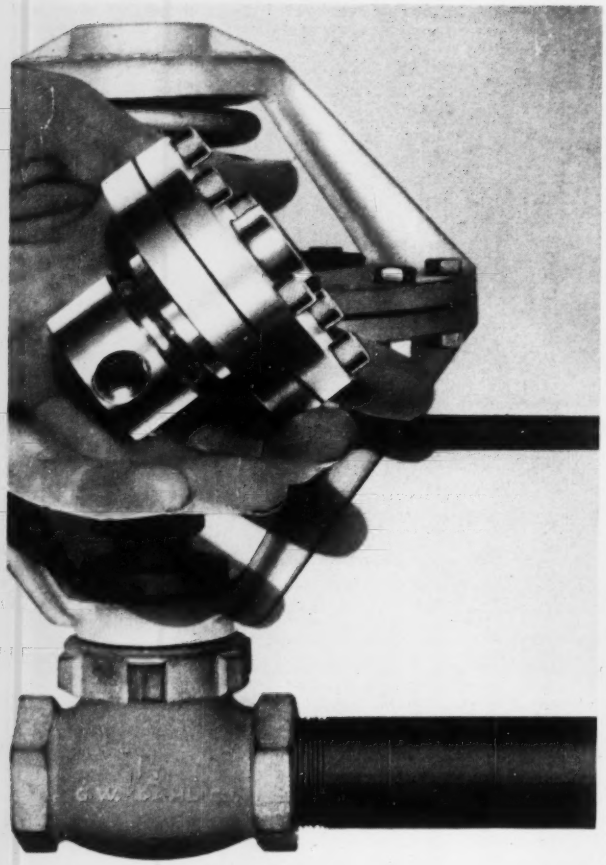
CHICAGO, ILL.—Comfortably seated in a control room, protected by two-foot concrete walls, these engineers rev up one of the world's most powerful jet engines—the J-57. The control room is the heart of an intricate system, developed

by Ford Aircraft engineers in collaboration with Minneapolis-Honeywell automatic control experts, that feeds back information from hundreds of engine parts affected during test runs. For example, the engineer at the right can make 96 separate readings—of temperatures and pressures—merely by pressing the push-buttons on the panel at his fingertips. The engine is in one of six huge concrete and steel test cells in an 18-acre laboratory. Each cell is operated remotely from its control room.

Optical Glass Properties

WASHINGTON, D. C.—The National Bureau of Standards recently has completed a coordinated study of the physical properties of five selected optical glasses, obtaining comparative data on refractive indices, spectral transmissive properties, densities, and thermal expansivities for each of the materials studied. The resulting charts and tables are expected to be of considerable utility in optical





From Pilot Plant to Process

The "Demi" diaphragm-operated control valve shown in the foreground was designed specifically for graphic panel installation. It is a packless "Demi" Model G, suitable for either vacuum or high pressure liquid or gas, pneumatically or hydraulically operated. The "Demi" valve is a barstock product available in many types of materials, with various porting arrangements, in ¼ inch IPS or integral tubing connections. "Bantam" models are available in larger sizes, both gland packed and packless, with flanged, screwed or socket welded connections and equipped with reverse or direct acting diaphragm operators.

George W. DAHL Company
BRISTOL, RHODE ISLAND

For more information circle **19** on inquiry card.

BORG MICROPOTS

the NEW STANDARD of precision multi-turn potentiometers

BORG 900 SERIES 3-TURN AND 10-TURN MICROPOTS

3-TURN MODELS 931-935 | 10-TURN MODELS 901-903

Standard models of Borg 900 Series Micropots offer such flexibility that the experienced designer needs. Borg has created a new standard for high-precision, multi-turn potentiometers.

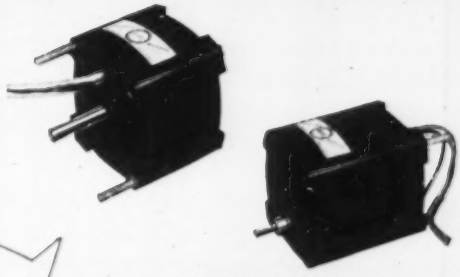
Advantages of the Borg 900 Series include greater accuracy, finer resolution, lower torque, longer life, better performance under severe conditions of vibration, greater adaptability and versatility of application.

Standard models include 10-turn precision Micropots in 1 to 5 gang models, 3-turn in 1 to 5 gang models, single or double shafts, servo or bushing mounts on either or both ends. Available to designers and engineers in any quantity.

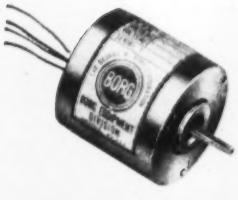
SYNCHRONOUS AND INDUCTION BORG-MOTORS

1000 SERIES 2 POLE AND 4 POLE MODELS
With and Without Gear Trains

These Borg-Motors were designed specifically for instrumentation, control and timing devices. They are recommended for all applications where low torque, constant speed and long life are positive requirements.



For Complete Engineering Data



SERVO-CONTROL
Borg-Motors

Two phase, 115 volt, 400 cps induction type Borg-Motors for servo control applications. Approximate size 1½" diameter x 2" long with a locked rotor torque of 0.82 ounce-inch.

ATTACH TO YOUR LETTERHEAD

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

NAME.....

TITLE.....

Please send complete information and engineering data on items checked.

- ☐ Precision Multi-Turn Potentiometers, 900 Series
- ☐ Borg Standard Potentiometer, 1100 Series
- ☐ Precision Multi-Turn Counting Dials
- ☐ Servo Control Motors
- ☐ Frequency Standards
- ☐ Instrument Motors
- ☐ Contract Manufacturing

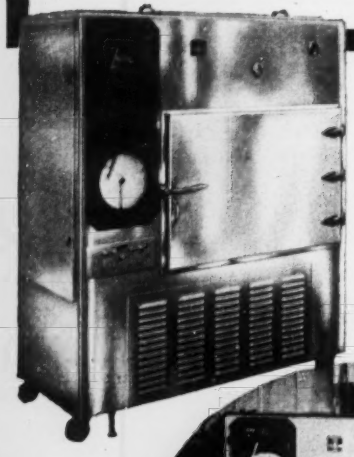
BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

For more information circle **20** on inquiry card.

FOR PRECISE AND RELIABLE ENVIRONMENTAL TESTS

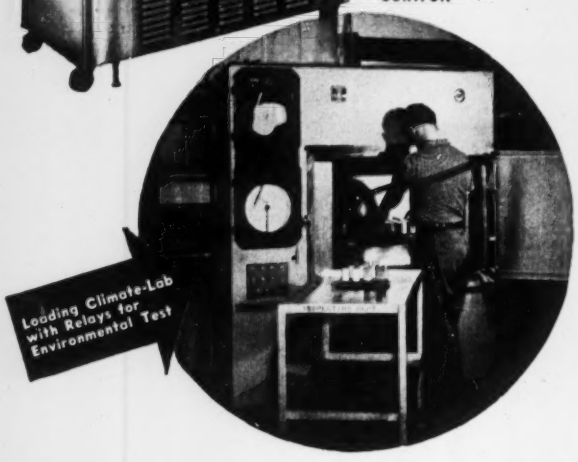
CLIMATE-LAB

Humidity-Temperature TEST APPARATUS With Program Control



Widely used by industry and government for producing conditions required by U.S. Armed Forces for acceptance testing in accordance with various program schedules.

Equally adaptable to atmospheric corrosion studies, development and quality control.



Loading Climate-Lab with Relays for Environmental Test

The Climate-Lab is ideal for testing the performance and durability of materials and devices under specific climatic conditions. It consists of a test chamber, air-conditioning unit, and control system, all embodied in a compact unit which affords precisely controlled variations of humidity and temperature repeated periodically according to predetermined programs, and provides a chart record of these variations.

FOUR TYPES OF HUMIDITY-TEMPERATURE CONTROL

1. Constant humidity and constant dry-bulb temperature.
2. Constant humidity and varying dry-bulb temperature.
3. Varying humidity and constant dry-bulb temperature.
4. Varying humidity and varying dry-bulb temperature.

Write for Bulletin 2242-H

AMINCO Laboratory Instruments

AMERICAN INSTRUMENT COMPANY, INC.

Silver Spring, Maryland • In Metropolitan Washington, D. C.

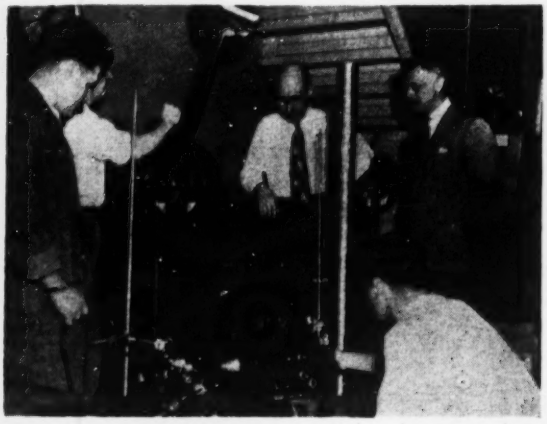
For more information circle **21** on inquiry card.

glass technology and research because they provide so great a variety of data on each specific glass.

Four spectrophotometers were utilized in measuring spectral and internal transmittance for the range 200 to 1000 millimicrons. Photo shows specimen on rotating table at left having its refractive index being measured by an infrared spectrometer. Densities were determined by the method of hydrostatic weighings with distilled water as the immersing liquid. Coefficients of linear thermal expansion were measured by a strain-gage method during three cycles of heating and cooling. Data collected are published in four papers appearing in the June 1954 issue of the *Journal of Research of the National Bureau of Standards.* (Vol. 52, No. 6), available from the Superintendent of Documents, U. S. Gov. Printing Office, Washington 25, D. C.

Photographic Service

NEW YORK, N. Y.—Two unique tools for industrial research and development—high-speed photography and time-lapse photography—are being offered as a field service by Sam Tour & Co., Inc., 44 Trinity Place, New York, N. Y.



High-speed motion pictures are used to analyze the action of rapidly-moving machine parts and other bodies in motion. Time-lapse photography uses exposures at intervals so that the action of hours, days, or weeks can be condensed into a smoothly-flowing sequence of several minutes. This technique is expected to be useful in studies of corrosion effects, crystal growth, sedimentation rates, emulsification, and other types of slowly evolving processes.

Blondes and Perspiration

MINNEAPOLIS, MINN.—There're some weird but practical goings-on in the laboratories of Minneapolis-Honeywell Regulator Co. Swedish blondes and man-made perspiration are just two of the unusual aides harnessed by the uninhibited researchers in their efforts to improve any one of the 9,000-odd different devices produced by the firm. However, it is all serious business. While most anyone would be interested in a pretty blonde, the researchers confine their interests to her hair. It seems that Swedish blonde hair makes the best reacting element for the humidity measuring devices that the firm manufactures. Brunettes and redheads qualified no better than pig bristles, horse hair or any of the other 20 to 30 materials tested.

The man-made perspiration? The researchers found that their own synthetic brew—a chemical formula—was more effective than the natural kind in studies of the effects of it on their product finishes. The kind that comes from our brow varies too much in chemical composition from person to person.

FISHER 1880

New! New! New!

FISHER®

Large Capacity

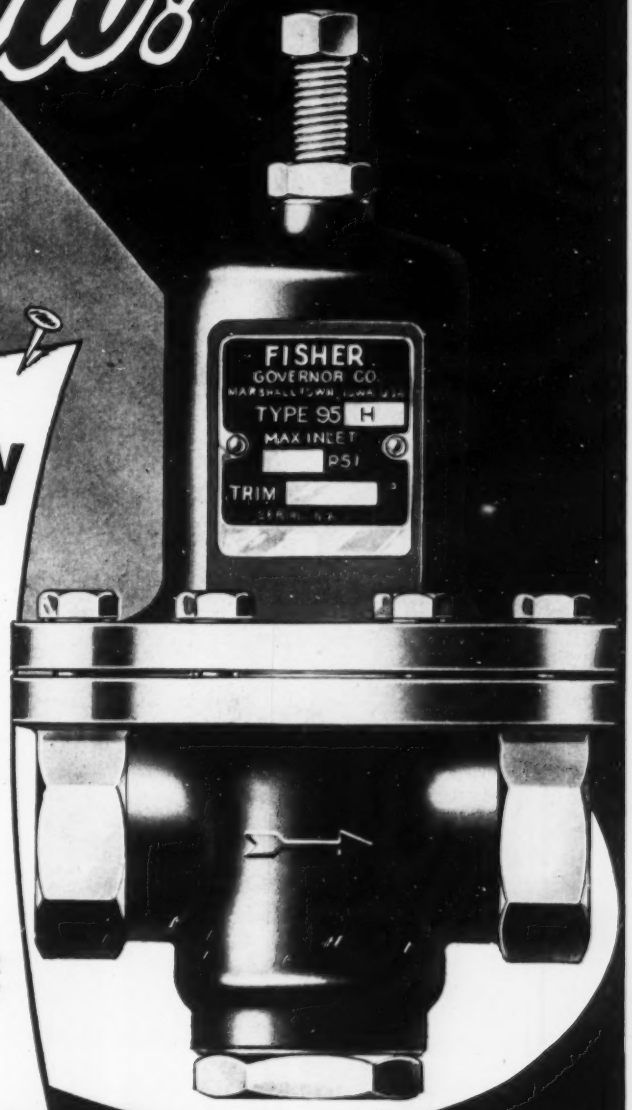
SERIES 95 PRESSURE REGULATOR

For steam, air, gas, oil, water or other fluid. Sizes ¼", ⅜", ½", ¾", 1". Outlet pressures from 2 to 30 psi; 15 to 150 psi. Easily installed—no external control lines.

Bulletin C-95 illustrates and describes new internal construction features which give higher capacity and close regulation. Write for your copy today.

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA

LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL



For more information circle **22** on inquiry card.

WHAT'S NEW AT BRISTOL...

Meet the WORLD'S SIMPLEST

It's Bristol's new METAGRAPHIC Pneumatic

for measuring, indicating, recording and controlling pressure, temperature, vacuum, flow, differential pressure, and liquid level

Here are a few of the advantages of Bristol's METAGRAPHIC system:

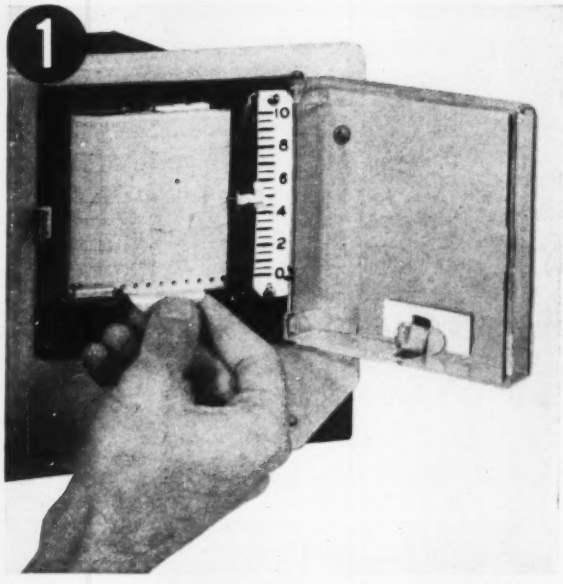
SIMPLICITY... fewer moving parts, fewer adjustments needed, and less service required. Range changes can be made in seconds.

FLEXIBILITY... all components are interchangeable. Units can be combined like building blocks to make up any kind of arrangement; functions can be located exactly where they're needed.

TRUE PLUG-IN SERVICE... provides great savings in installation costs. And if trouble is suspected with any component, just pull the doubtful unit out and plug in a stand-by—*without stopping any processing.* The suspected unit can be taken to the shop and checked whenever time permits. You don't lose any air pressure when changing units, either. Bristol's automatic sealing system prevents loss of signal to other components.

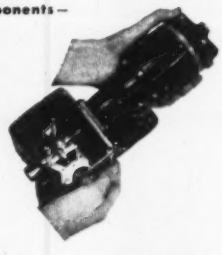
NO TIME LAGS... in a four-pipe circuit the transmitter signal and the controller-output signal travel around a very short loop—which can be as little as three feet long.

These are some of the important advantages of Bristol's METAGRAPHIC instrument system—the product of over 60 years of experience in instrument making and application in practically every industry. Get the whole story by writing to The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.



IT TAKES ONLY SECONDS to change the Bristol METAGRAPHIC receiver from a recorder to an indicator: Case door is opened...

Here are the basic components—



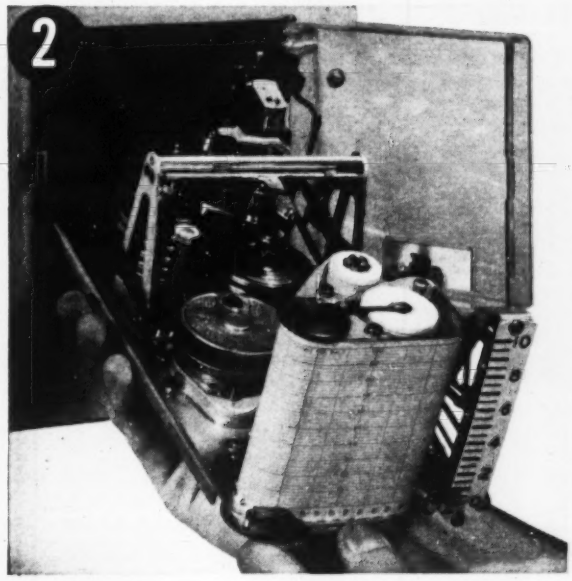
BRISTOL PNEUMATIC TRANSMITTER, with cover removed to show simplicity of the world-famous Bristol measuring element. The frictionless transmitter, with only one pivot and no flexures, will operate in any position, indoors or out. The unit is sensitive to extremely small changes in the measured quantity, as minute as 0.03% of range, including reversal.

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

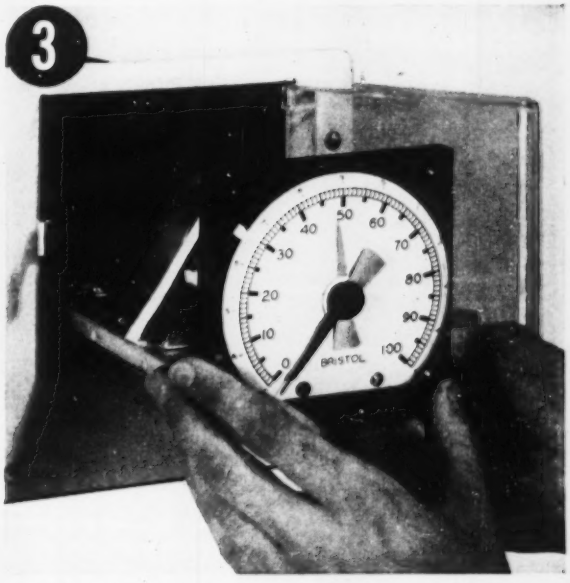
For more information circle **23** on inquiry card.

INSTRUMENT SYSTEM!

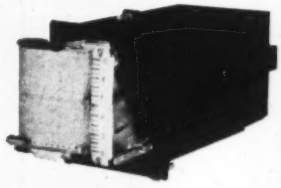
Transmission instrument system . . .



Recorder chassis withdrawn from case (air pressure is automatically maintained) . . .



Indicator chassis is plugged into same case. Control remains undisturbed throughout change-over.



HERE'S THE RECORDER CHASSIS, in retracted position. Now pen can be inked, set point and zero adjustment made without disturbing record or control. You can bring up to three related variables, such as flow, pressure and temperature, into one receiver. Auto-manual switching is foolproof and "bumpless," without disturbing valve position.

THE BRISTOL CONTROLLER can be plugged into back of receiver, placed at process, or used as a "blind controller." Available in on-off, proportional, proportional plus reset, proportional plus derivative, and proportional plus reset plus derivative. Experienced instrument men will recognize this as a unit service-proved by thousands of installations.*

*Licensed under C. B. Moore patents

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

BRISTOL

THE DEPENDABLE GUIDEPOST OF INDUSTRY

For more information circle **23** on inquiry card.

Arthur Marquis
Design and Application Engineer

Arthur R. Kozlowski
Design and Application Engineer

John H. Smedley
Design and Application Engineer

George D. Barcus
Design Engineer

Rollin J. Parker
Supervisor—Magnetic Products Design and Application

These Carboloy® permanent

At the modern Carboloy magnet laboratory, in Detroit, trained engineers work with the finest equipment. Where necessary, special instruments are often designed by the engineers.

With such complete facilities, Carboloy magnet engineers can give you accurate information, quickly. And, they can thoroughly test their designs and the performance of the magnets in your products.

DC Recording Hysteresigraph. Simultaneously plots magnetic force and resulting magnetic induction. Produces complete hysteresis loops, not ordinary point-by-point readings.

High H-Permeameter. Provides point-by-point readings of magnetizing force and induction. Control table and Ballistic Galvanometer also used for general flux measurements.

Condenser Discharge Magnetizer. Produces very large current impulse for magnetizing magnet configurations that can best be accomplished with special field shapes.

Ernest E. George
Mgr.—Design and Application Engineering

Robert J. Studders
Supervisor—Magnetic Materials and Process Development

Edgar W. Engle
Mgr.—Product and Process Development Engineering

Edgar L. Hubbard
Sales Mgr.—Permanent Magnets

magnet engineers can help you improve products, cut costs

Experienced magnet engineers, using the latest test and development equipment, will provide complete engineering appraisal service

You can get valuable technical assistance, without obligation, on the design and application of permanent magnets, from Carboloy magnet engineers . . . men who are leaders in the field.

Only at the Carboloy Department can you obtain engineering appraisal service and sample magnets from separate laboratory facilities devoted exclusively to helping you determine the design and optimum size, shape and strength magnets to fit your particular application. Your product will be tested in the modern Carboloy magnet laboratories, on the latest test instruments, to assure the maximum operating efficiency of the magnets.

PROVED RESULTS

The assistance Carboloy engineers have given other designers and manufacturers has paid off time and again in lower production costs, improved product efficiency, simplified assemblies and reduced product size.

You can rely on their solutions because these engineers, many of whom worked on the original development of Alnico, are specially trained and experienced in all phases of permanent magnet design and application.

You can depend on Carboloy magnet sales engineers, too, for authoritative and intelligent answers to your questions. These men have intensive, special training in permanent magnets, supporting their engineering and technical backgrounds.

A COMPLETE SERVICE

Together with the engineers who are working on the development of new magnetic materials and on the improvement of existing Alnico grades, *these men make a complete permanent magnet team.* Their sole job is to help you utilize the tremendous potential of permanent magnets for new and improved products.

This team can start working for you, today. Just fill out the coupon and attach to it your company letterhead, and where possible, blueprints or sketches of the job. Or, if you prefer, the coupon will bring a call by your local Carboloy magnet sales engineer.

Three typical, successful appraisal projects:

INSTRUMENTS. Working with Thomas A. Edison, Inc., Carboloy engineers provided the magnet design that made possible a revolutionary fire detection relay. Use of the proper magnets simplified the design of the relay and reduced its size and weight.

CONTROLS. The development of the hysteresis brake was pioneered by Carboloy magnet engineers. Now widely used in the textile and wire rope industries, this brake eliminates friction, while maintaining the necessary constant tension.

TELEVISION. Carboloy magnet engineers collaborated with tube engineers on the design of a new magnetic internal focusing device. They designed the smaller, more efficient magnets that helped eliminate focusing dials and external assemblies.

CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY

"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company

CARBOLOY
Department of General Electric Company
11155 E. 8 Mile Ave., Detroit 32, Michigan

☐ I would like magnet engineering assistance; I am enclosing necessary information and blueprints.

☐ Have a Carboloy magnet salesman call.

Name _____ Position _____

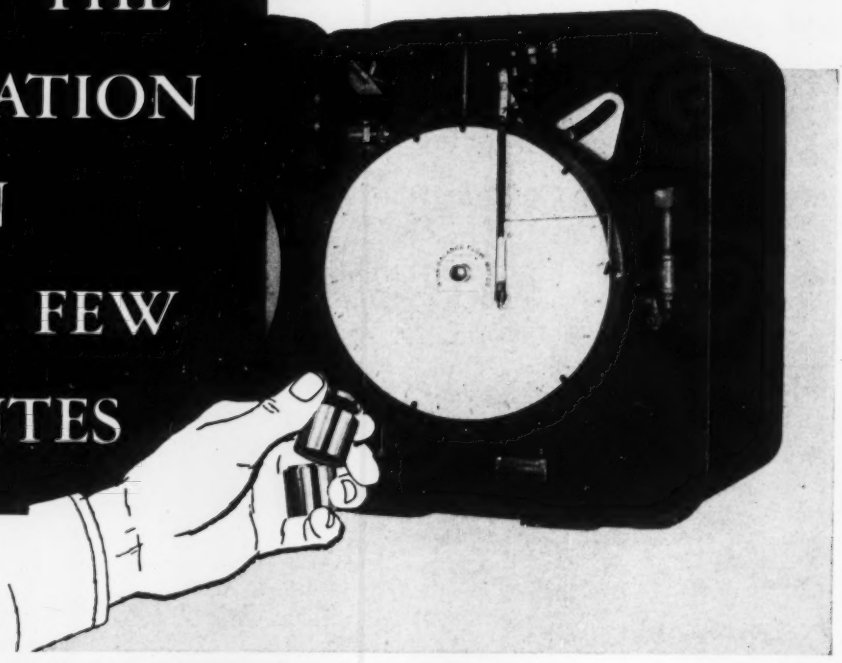
Company _____

Address _____

City _____ Zone ____ State _____

For more information circle **24** on inquiry card.

CHECK THE CALIBRATION IN JUST A FEW MINUTES



A routine check of the calibration of any Hagan Ring Balance Meter takes just a few minutes. One man can make the check, and he only needs the calibrated dead weights furnished with the meter.

The check can be made with the measuring element under full static pressure, and without requiring a manometer or other cumbersome testing equipment.

The procedure is simple. Equalize the meter, hang calibrated weights on the ring element, and compare the pen arm position with the total dead weight used.

The ease and simplicity of the dead weight method makes meter checking an easy operation, instead of a real chore.

The Hagan Ring Balance Meter design includes many other advantages, such as these:

- No stuffing boxes or pressure-tight bearings to leak or to add friction.
- Mercury level is not critical.
- Full scale differential with any ring is adjustable over 7:1 range.
- Sensing elements are interchangeable for full scale differentials from 1″ to 420″ WC.
- Pneumatic or electric signal transmitters are available for remote recording or for automatic control purposes.
- Simple automatic compensation for such factors as fluid density, pressure or temperature is a standard attachment.
- Two rings, measuring separate quantities, can be mounted in a single meter housing. Individual measurements can be recorded separately, as well as added or subtracted.

We will be glad to suggest the metering equipment best suited for improving an existing installation, or for extensions and new construction.

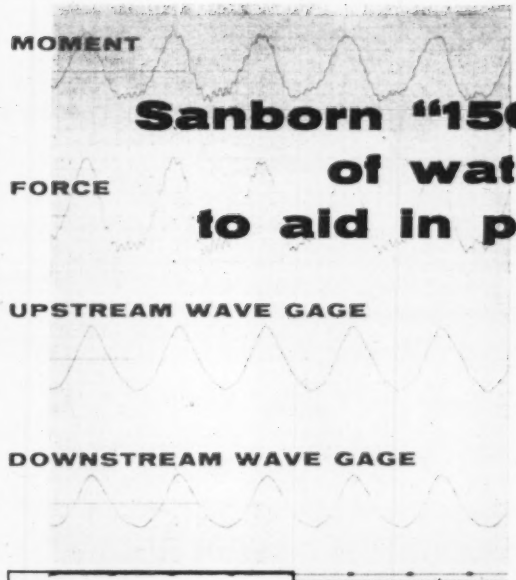
HAGAN HALL BUROMIN CALGON

Hagan Corporation

HAGAN BUILDING, PITTSBURGH 30, PA.

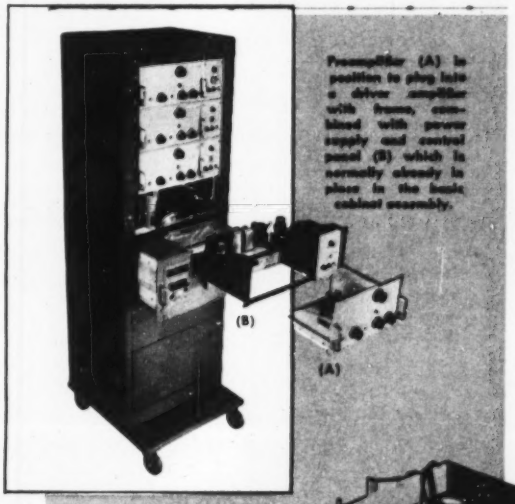
Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems Control Systems for Automotive and Aeronautical Testing Facilities

For more information circle **25** on inquiry card.



Sanborn "150" records the effects of water wave forces to aid in pile structure design

By means of a Sanborn 150 Oscillographic Recording System equipped with four carrier type preamplifiers, engineers at the M.I.T. Hydrodynamics Laboratory are getting accurate pictures of simulated shallow water waves and their effect on dummy piles. The shape and length of precisely controlled waves in a 90 foot glass flume are plotted simultaneously with their moment and force on a suspended cylindrical pile. The excellent frequency response available with this method permits a sensitivity and accuracy not obtainable in previous model studies of this type.



Preamplifier (A) in position to plug into a driver amplifier with frame, combined with power supply and control panel (B) which is normally already in place in the basic cabinet assembly.

This is but one of MANY applications possible with Sanborn 150 Oscillographic Recording Systems

Virtually all electrical phenomena, within a frequency range of zero to 100 cps, can be accurately, permanently and graphically registered by Sanborn Oscillographic Recording Systems. This versatility of application is possible because of the *flexibility* of Sanborn 150 Series Recording Systems. A wide variety of quickly *interchangeable* pre-amplifiers, which plug in to *built-in* driver amplifiers (illustrated at left), are available for use with Series 150 Systems, to record such phenomena as: stress, strain, pressure, displacement, thickness, velocity, acceleration, current, voltage, temperature, torque, light, flow, force, load, position, rpm, radiation, tension, and power.

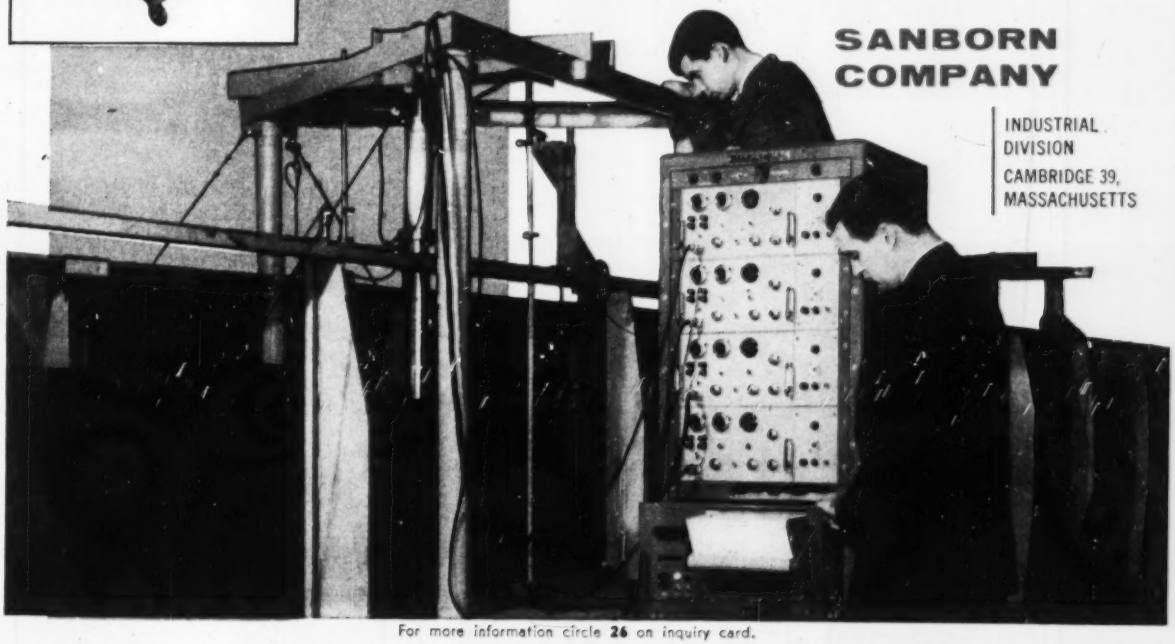
Add to this versatility the Sanborn features of inkless tracings in true rectangular coordinates, on plastic coated chart paper . . . high torque movement . . . time and code markers . . . numerous chart speeds.

Let Sanborn Answer YOUR Recording Requirements

For informative technical data on the basic 1, 2, and 4 channel Sanborn systems, and qualified counsel to help you select the correct Sanborn equipment for your requirements, write to

SANBORN COMPANY

INDUSTRIAL DIVISION
CAMBRIDGE 39, MASSACHUSETTS



For more information circle **26** on inquiry card.

CRESCENT

Polyethylene

MULTITUBE

CRESCENT POLYETHYLENE MULTITUBE is your answer for economy with lasting dependability in your instrument tubing problems.

CRESCENT POLYETHYLENE MULTITUBE is composed of 2 to 19, ¼" O.D. Polyethylene tubes up to 1000 feet in length, **spirally cabled together** to allow bending with a short radius without distortion of the tubes. The tubing assemblies are protected by a flexible interlocking galvanized steel armor (Type PA), or by a tough corrosion-resistant thermoplastic sheath (Type PT). One bright blue tube in each layer permits a ready identification of each tube at both ends for ease of connection.

TYPE PA—The galvanized steel armor provides complete protection from injury during and after installation. In the event of fire, the molten Polyethylene is retained within the armor.

TYPE PT—The polyvinyl chloride thermoplastic sheath provides good mechanical resistance, with complete corrosion resistance, and it is flame retarding.

Economy is achieved in the initial cost of CRESCENT POLYETHYLENE MULTITUBE and its accessories, as well as in substantial savings in labor costs of installation. Moderate to long length runs of light weight and compact MULTITUBE assemblies result in fewer connections and fittings, lower cost for supports or racks, ease of mounting, with less space being used.

CRESCENT POLYETHYLENE MULTITUBE can be pulled through conduit or raceways.

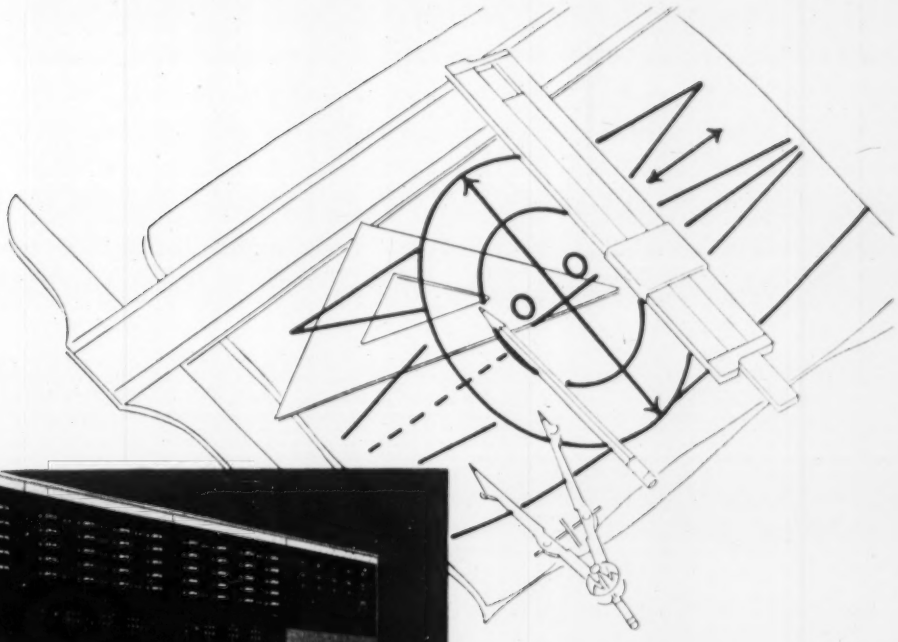
Send for Bulletin giving complete information and engineering data

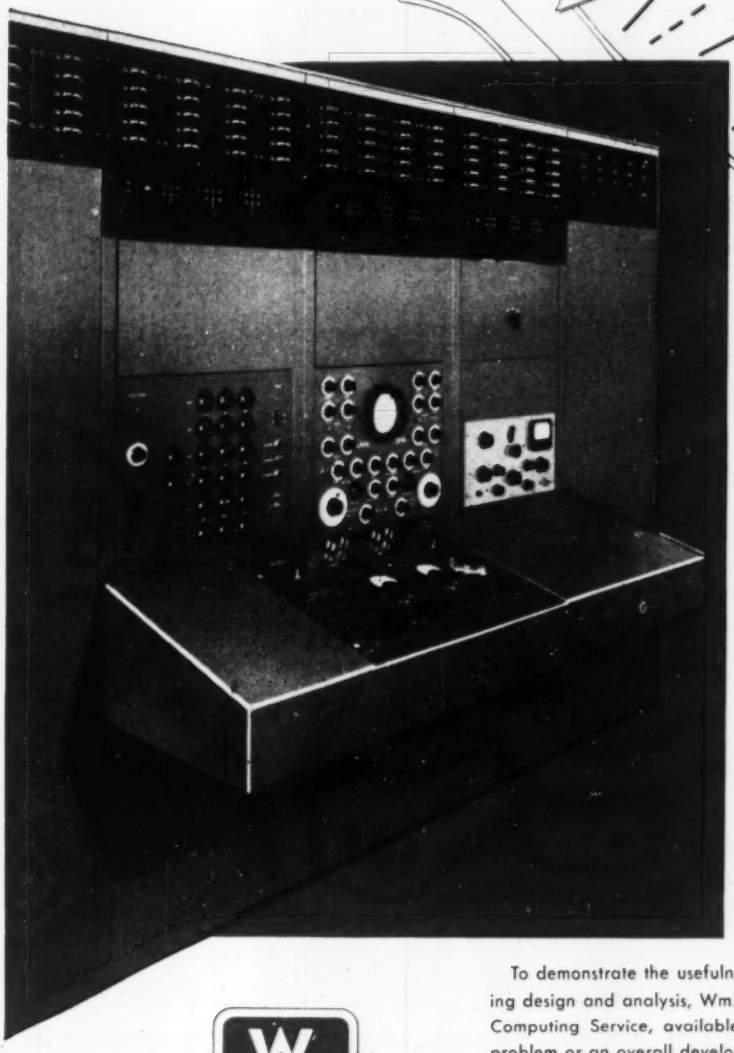
CRESCENT

INSULATED WIRE & CABLE CO.

TRENTON, NEW JERSEY

For more information circle **27** on inquiry card.





Save Development Time...

REDUCE COSTS

Evaluation of design without actual construction of preliminary models is today an engineering necessity. The MILAC Analog Computer makes this short-cut possible by rapid solution of mathematical-electronic models of new systems or structures. Different approaches and solutions may be tried out more freely, for the cost of construction and test of prototypes for each design change is eliminated. Development costs and engineering man-hours are thus vastly reduced, for the MILAC accurately predicts and rules out faulty designs before final performance tests.

To demonstrate the usefulness of the MILAC Computer in engineering design and analysis, Wm. Miller Instruments maintains an Analog Computing Service, available for solution of either a single design problem or an overall development program.

Detailed information about either the MILAC Computer or the Analog Computing Service will be sent on request.

WM
PASADENA

WM MILLER INSTRUMENTS, INC.

CUSTOM INSTRUMENT DESIGNERS AND MANUFACTURERS

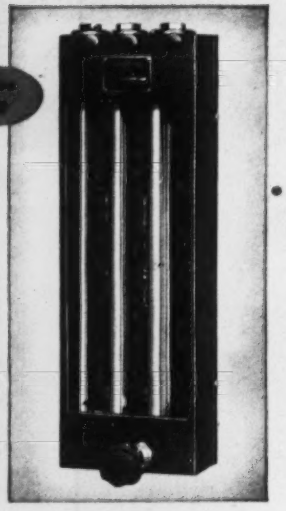
325 N. HALSTEAD AVENUE · PASADENA 8, CALIFORNIA · RYAN 1-6317

For more information circle **28** on inquiry card.

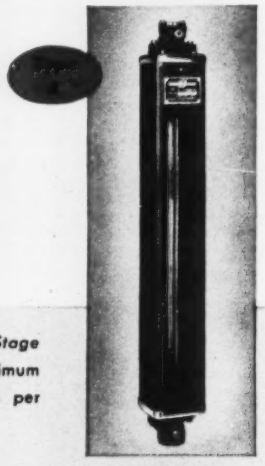
DO YOU USE FLOWMETERS FOR LABORATORY RESEARCH OR PRODUCTION?

COX FLOWMETERS

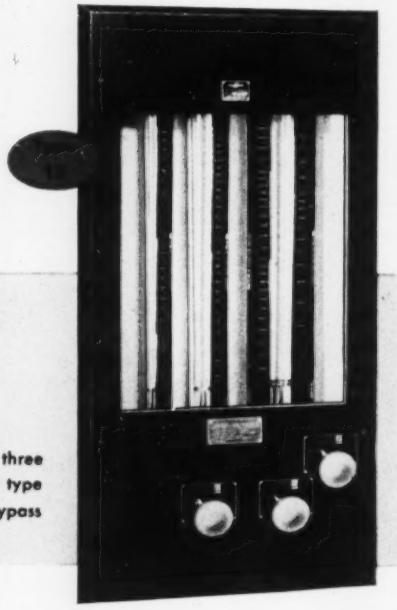
are designed for flow rate measurement of fuels (such as gasoline, kerosene, diesel and jet fuel) and of many liquids and gases. They are built for use in the laboratory, in a wide range of production processes, or for a combination of the two.



For the Laboratory: *Type 10 Multiple Stage Flowmeters,* designed as a compact laboratory instrument for precise measurement of smaller fluid flow rates.



For Production: *Type 8 Single Stage Flowmeters,* engineered for a maximum flow capacity of 50,000 pounds per hour.



For Both: *Type 12 Multiple Stage Flowmeters,* available in three series — the 40, the 90, and the 100. Each has logarithmic type scales for excellent readability and can be equipped with a bypass orifice to greatly increase flow capacity.

Individually graduated scales; patented "Inner Wall" guides that insure perfect float centering within the metering tube; and extra-sensitive floats are a few of the major features of Cox Flowmeters. Scales are graduated for a specific fluid. Scales for metering other fluids can be easily interchanged. Multiple Stage Flowmeters are available for wide flow ranges, and bypass orifices can be built in which greatly increase the flow capacities without increasing panel space required.

The Type 12, 40 Series Flowmeter, available in single and multiple-stage units, is firmly established as the most accurate variable-area flowmeter now made. Each individually graduated logarithmic scale is accurate to within ±½ percent of the actual flow at any point on the scale. It is readable to within ±¼ percent of indicated flow at any point.

Look for Other **CRL** *Products*

- AIR FLOWMETERS
- CARBURETOR FLOW STANDS
- ENGINE INDICATORS
- FLOWMETER CALIBRATING STANDS
- FUEL NOZZLE TEST STANDS
- MAGNETIC THICKNESS GAGES
- VIBRATION RECORDING EQUIPMENT
- BALANCED ELECTRONIC EQUIPMENT FOR PRESSURE AND VIBRATIONS

Commercial Research Laboratories, Inc.

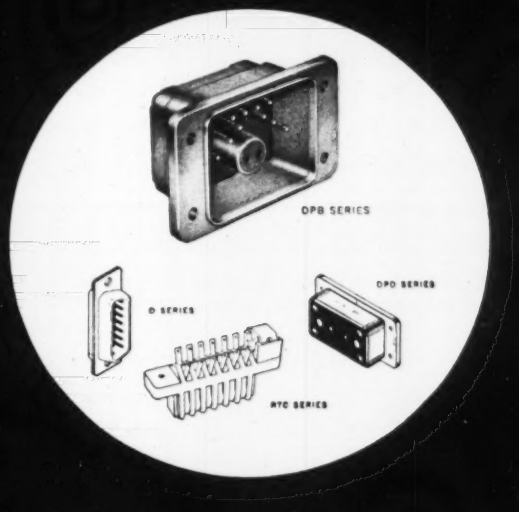
20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

U. S. PATENTS 2,384,800
2,389,957
2,403,849
2,417,352

Makers of REGISTERED TRADE MARK *Since 1912*

For more information circle **29** on inquiry card.

Circle **30** on inquiry card.



for rapid disconnect

use cannon

"unit plug-in"

connectors

speed up inspection...testing...maintenance! facilitate interchangeability!

You can connect, disconnect, interchange, replace, test, and inspect instruments, assemblies, and sub-assemblies easily and rapidly when you use Cannon "Unit Plug-In" multi-contact electric connectors.

You'll find some with shells . . . some without. Shell style units . . . in a wide variety of designs . . . are ruggedly constructed to take the many "in" and "out" operations of rack, panel, chassis, and sub-assembly applications. Varied, simple, but always rigid mounting facilities provided on each connector half. Standard, miniature, sub-miniature sizes. Either connector half may be made into a plug by use of an end bell.

Up to 156 contacts. And . . . an amazing number of combinations of contacts for control, audio, thermocouple, co-ax, twin-ax, as well as pneumatic connections. In single- or double-gang. Special moisture-proofed types. Standby units feature gold-plated contacts to withstand deterioration and corrosion.

Write for full information. Write TODAY!

SINCE 1915

first in connectors

CANNON PLUGS

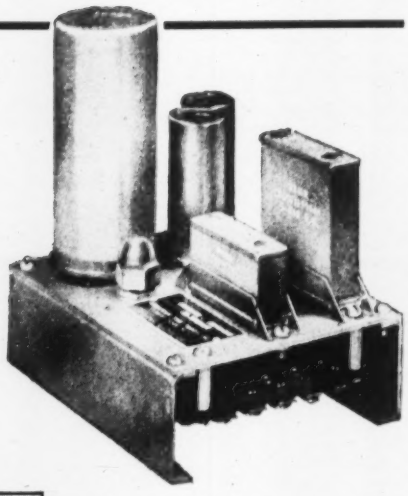
Please refer to Dept. 180

CANNON ELECTRIC COMPANY, 3209 Humboldt Street, Los Angeles 31, California. Factories in Los Angeles; East Haven; Toronto, Canada; London, England. Contact representatives and distributors in all principal cities.

40.109
240.65
1174.6
20000.
– OR ANY OTHER

precision

FREQUENCY



CALIBRATED AGAINST A STANDARD ACCURATE TO 1 PART IN 10-MILLION

The basic unit of this frequency standard is an electronically driven fork,—temperature compensated and hermetically sealed against changes of humidity and barometric pressure. Through its use, any frequency or multi-frequencies between 40 and 20,000, fractional or otherwise, are obtainable.

FROM 40 TO 20,000 CYCLES

CONSERVATIVE ACCURACY UNDER USUAL CONDITIONS

1 PART IN 100,000—(.001%)

Have you a need for any specific number of cycles in precision frequencies?

Can a source of such frequency solve your design problem or increase its factor of safety?

Have you a system that requires great accuracy, stability and dependability?

The frequencies shown at the top of the page are but a few among hundreds furnished for precision application in industries, laboratories and Government departments.

OUR ENGINEERS ARE AVAILABLE TO COOPERATE ON ANY PROBLEM

American Time Products, Inc.

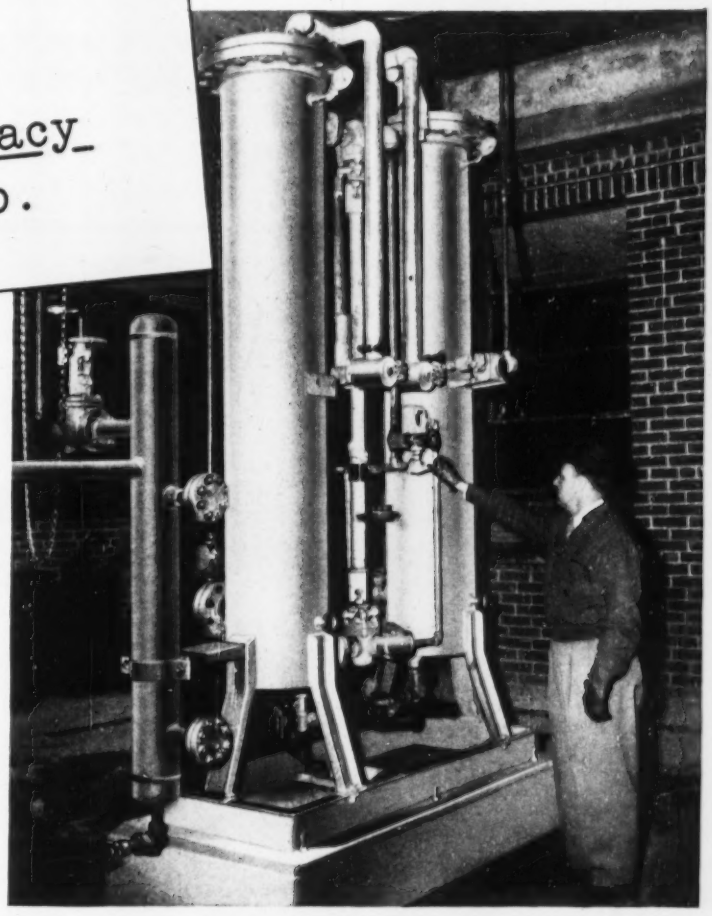
580 Fifth Avenue ***New York 36, N. Y.***

MANUFACTURING UNDER PATENTS OF WESTERN ELECTRIC CO.

For more information circle **31** on inquiry card.

Case No. 64

Kemp Dryer Assures Accuracy For Sun Oil Co.



How SUNOCO® guarantees dependable instrument readings 24 hours a day

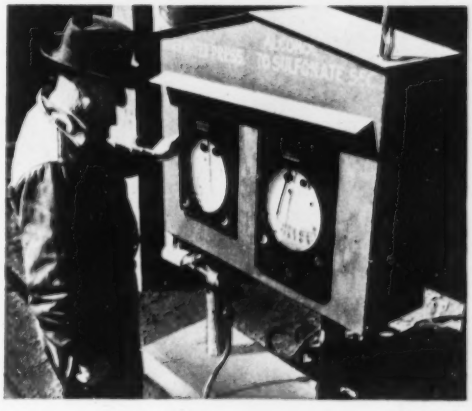
WHEN the Sunoco Plant at Marcus Hook, Pa., introduced a new process at the beginning of the year, many new instruments were installed. To dry the compressed air operating these instruments and assure accurate readings, Sunoco installed a Kemp Model 300 S Dryer.

Kemp Dryer Entirely Satisfactory

According to Harold Powers, Instrument Supervisor at Sunoco, the Kemp Dryer has been entirely satisfactory in performance. Operating continuously day and night since installation, it has performed according to specifications, has never been saturated, and has required very little attention.

Kemp Dryers for Every Purpose

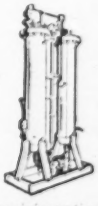
Kemp offers a variety of dryer models to meet all problems. Designed to dry air to sub-zero dew points at low cost, they are constructed of quality materials and embody the engineering knowledge gained from Kemp's many years of experience. They are available with manual, semi-automatic, or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each specific drying job. If you have a problem involving the removal of water from air, gases, or liquids, contact Kemp engineers now.



Accurate readings depend on constant, dependable supply of dry air. Harold Powers, Instrument Supervisor at Sun Oil Company's Marcus Hook plant, is shown reading two of many instruments relying on Kemp-dried air to assure dependable readings.

For more complete facts and technical information, write for Bulletin D-27 to:
THE C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.

KEMP OF BALTIMORE



DYNAMIC DRYERS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • INERT GAS GENERATORS
SINGEING EQUIPMENT

For more information circle **32** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

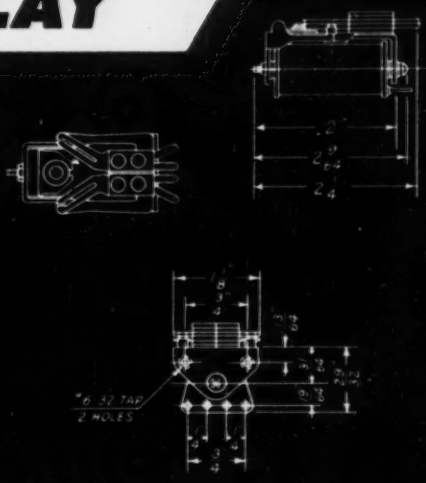
You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

Here's a CLARE RELAY



that has changed a lot of design ideas

Compare these features of the CLARE Type J Relay with ordinary telephone-type relays

Extremely Small Size—Length: 2¼", Width: 1⅛", Height (with 10 springs): 1¾", Net Weight: 2¼ oz. (approx.).

Large Current Capacity—Rated current carrying capacity: 4 amperes, 150 watts. Twin contact points (Palladium) standard.

Exclusive New Features—Twin contacts operate independently of each other—minimize chance of contact failure.

Largest possible bearing surface for hinge-type armature.

Armature bearing pin turns in cylinder of different metal which is full width of the heelpiece.

Heelpiece designed and processed for extreme rigidity to take and hold fine adjustments.

Versatile Operation—Standard coils provide for fast operate and fast release (minimum of 1 to 2 milliseconds). Coils may be provided for time delay on operation, time delay on release, or both. Also available, double-wound coils. Operating voltage up to 220 volts d-c.

Armatures may be single (right or left) or double. Residual: lock screw (adjustable) or fixed.

Relays may be mounted on mounting bases or strips as well as upon mounting bars and individual mounting brackets. Also available with plug-in mounting.

Available with slip-on dust-tight covers or hermetically sealed in metal enclosures.

• No fully acceptable substitute has ever appeared for the conventional telephone type relay. It offers a versatility of performance and flexibility of installation that meet the requirements of the widest variety of industrial designs.

Prior to the introduction of the CLARE Type J Relay, however, designers were handicapped by the comparatively heavy weight, large size and certain operational limitations of this type of relay.

The CLARE Type J changed all this. Here, for the first time, was a light-weight, small-size relay of the telephone type. It not only gave comparable performance advantages but added certain exclusive features which offered a new conception of efficient, long-life relay operation.

This relay, among other features, provided *independent* twin contacts to preclude contact failures; the largest possible armature bearing surface, thus insuring stable operation and little adjustment change over a great number of operations; and an extremely rigid heelpiece to take and hold fine adjustments. (A fine adjustment will shift when a weak heelpiece is distorted by tightening the mounting screws.)

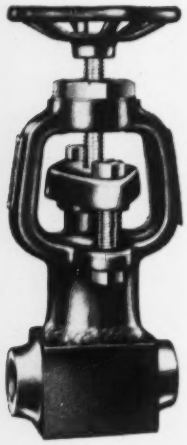
Acceptance of the CLARE Type J Relay has been phenomenal. It has replaced the old style telephone type relays in innumerable designs where small size and light weight were of prime importance. If you are not familiar with the features and characteristics of this relay, we invite you to contact your nearest CLARE sales engineer or write to: C. P. Clare Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY. ***Write for Engineering Data Book.***

CLARE RELAYS

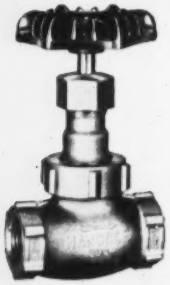
FIRST IN THE INDUSTRIAL FIELD

For more information circle 33 on inquiry card.

for the economy of quality...

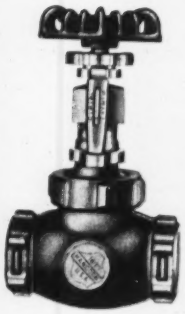


1500# Instrument Valves. For services that require constant or intermittent high temperatures. Recommended for use as a root or sampling valve because it is rugged, compact and comparatively light in weight. Made of forged Chrome Moly Steel with disc and integral seat of Cobalt-Chromium-Tungsten Alloy, Hard Facing – "420 Brinell". **No Bonnet Joint Design. Sizes:** ¼", ⅜" and ½". **Types:** Globe and Angle. **Connections:** Screwed and Socket Weld Ends. **Service Ratings:** For all pressures up to 1500# at 1050° F. – O.W.G. 100° F.

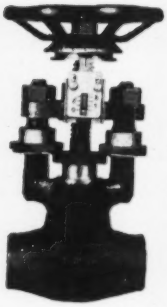


Bronze Valves. Extra tough for leak-proof service. 125% to 230% stronger diaphragm than ordinary bronze valves. **Types:** Globe and Angle. **Sizes:** ¼" through 2". **Connections:** Screwed Ends. Available in 150#, 200# and 300# W.S.P. ratings 550° F.

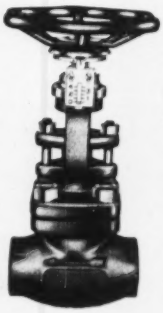
"Flocontrol" Valves. 3-in-1 design combines variable orifice, shut-off and index. Scientifically designed V-Port valve disc compels proportional flow throughout the entire lift of the valve stem.



Bronze "Flocontrol" Valves. Sizes: ¼" through 2". **Types:** Globe and Angle. **Connections:** Screwed Ends. Available in 150# and 300# series.



600# Steel "Flocontrol" Valves. No Bonnet Joint Design. Sizes: ¼" through 1". **Types:** Globe and Angle. **Connections:** Screwed, Socket Weld and Flanged Ends. Available with 150#, 300# and 600# series flanges.



600# Steel "Flocontrol" Valves. Bolted Bonnet Design. Sizes: 1¼" through 4". **Types:** Globe and Angle. **Connections:** Screwed, Socket Weld and Flanged Ends. Available with 150#, 300# and 600# series flanges.

HANCOCK VALVES

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your telephone. Take advantage of his knowledge and experience in selecting the right Hancock Valve for each service requirement. You can depend on him for prompt deliveries from local stocks.

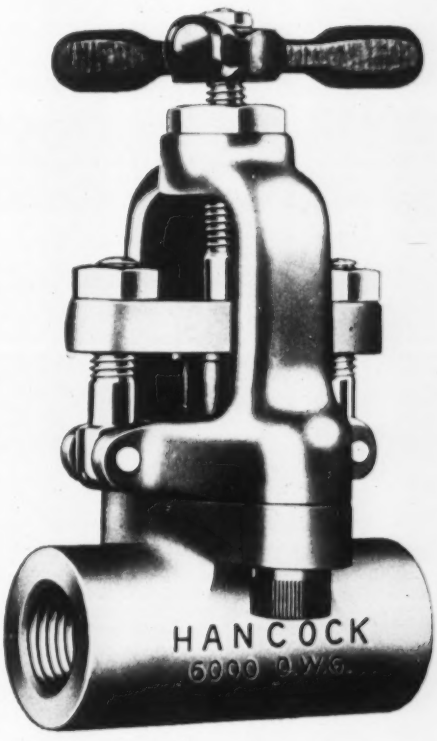
specify HANCOCK VALVES

To get the most value from your valve investment, you must have the assurance of efficient, trouble-free performance.

Hancock Valves give you economy of quality that makes them your best buy in terms of long, reliable service. They have advanced construction and operational advantages found in no other valves — features backed by more than 75 years of pioneering new designs, new materials and new manufacturing techniques in anticipation of changing needs.

Rugged, precision-built Hancock Valves are noted for dependable tightness month after month under the most adverse conditions of use. They do a job and stay on the job—withstand the deteriorating effects of wire drawing, galling, steam cutting, erosion and corrosion far longer because they are functionally designed and made from carefully selected materials of the highest quality. Standardization of parts in all sizes of each type of valve provides the interchangeability factor so essential to simplified inventory and low-cost maintenance.

The operational perfection and extra service life engineered into all Hancock Valves are yours at the cost of ordinary valves. Whether you are adding new capacity to present facilities, planning a new plant or a revalve project, learn all the money-saving reasons why Hancock Valves belong in your specifications. Complete information is yours on request.



6000# Stainless Steel Instrument Valves. For use on instrument panels, instrument, gauge, by-pass and corrosive lines, orifice meters and similar services where high temperatures are of short duration and occur infrequently. Weight and space savers. **Sizes:** ¼", ⅜" and ½". **Types:** Globe and Angle. **Connections:** Screwed and Socket Weld Ends. **Service Ratings:** For all pressures up to 6000# — O.W.G. 100° F.

When Hancocks go in, valve costs go down.

1877 HANCOCK U.S.A.

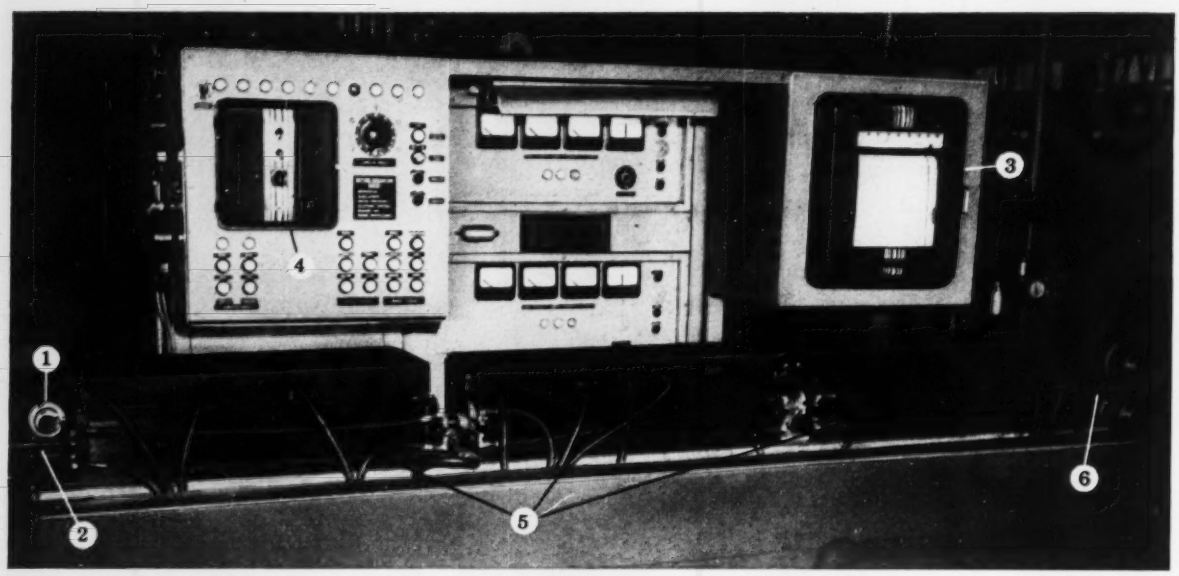
A PRODUCT OF MANNING, MAXWELL & MOORE, INC.

WATERTOWN 72, MASSACHUSETTS

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

MAXWELL MANNING, MAXWELL & MOORE, INC. TRADE MARK

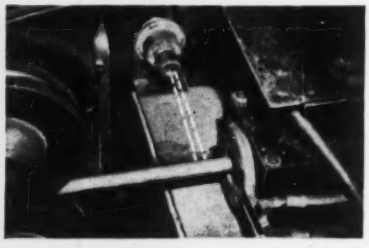
For more information circle **34** on inquiry card.



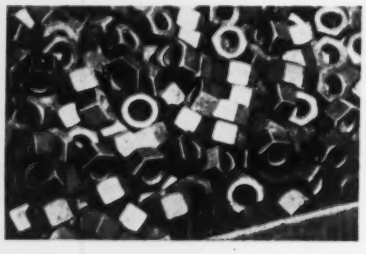
Rayotube (1) detects temp. of heated stock (2) from coils.

Speedomax controller (3) and L&N control unit (4) regulate power to induction coils (5).

Cold bar stock (6) entering coils.



Rayotube (above), positioned only 9" from bar, can be focused on an area as small as 0.1" in diameter at 4". Due to fast, controlled heating, punched blanks (below) are clean . . . scale free.



SPEEDOMAX-RAYOTUBE "TEAM" READILY CONTROLS

H-F induction heating

AT LAMSON & SESSIONS CO.

• Thanks to a Tocco high frequency induction heater and L&N Speedomax® temperature control, the Lamson & Sessions Company's East 63rd St. plant in Cleveland not only increases its nut-forming capacity but at the same time eliminates rejects due to scale.

This equipment replaces two conventional hot punching machines and increases capacity 50%. Round bar stock is first fed into the coils of the 3,000 and 10,000 cycle induction heaters. As the hot bar emerges, it moves into a cut-off and nut-forming machine which produces 4200 blanks an hour. The formed nuts drop into an oil quench . . . are later picked up by a steel conveyor.

Despite changes in line voltage, or in bar size, composition or speed through the induction coils, the equipment's Rayotube® detector, in combination with its Speedomax controller, keeps bar at uniform forging temperature. The Rayotube sights directly on the hot bar as it emerges from the coils . . . rapidly follows its temperature changes. If temperature is above or below 2350 F, the Speedomax throttles a motor-operated rheostat to regulate power input to the induction coils . . . and thus keeps bar at desired heat.

If you'd like more details about using the L&N Rayotube and Speedomax team on high frequency induction heating or similar applications, just write us at our nearest office, or at 4955 Stenton Ave., Phila. 44, Pa.

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For more information circle **35** on inquiry card.

Guest Editorial . . . .

AVIATION INSTRUMENTS

by W. G. BROMBACHER*

CHALLENGE of the air age, and a few of the dramatic achievements, are shown pictorially on pages 928 and 929 of this issue. Aviation instrumentation as a business differs from industrial instrumentation in the way progress is made. The government is the chief buyer of aviation instruments and largely sets the pace of development by performance specifications, often based on performance needs not yet reduced to a feasible instrument design. Obviously the manufacturer must often bid on instrumentation in his field even though the performance required is at the moment beyond his present technical know-how or that of his competitors.

On the other hand, in industrial instrumentation new developments are spurred by customer requirements and by the achievements of competitors. But before assuming any firm obligation to deliver, the instrument has usually been developed and tested, and is ready for manufacture. It is fair to assume that the pace in industrial instrumentation can be somewhat more leisurely.

One other fact makes the lot of the aviation instrument engineer even harder—he finds it hard to get technical details if a competitor gets the jump in meeting increased demands for performance or in developing a superior design. A sample cannot usually be bought and there is considerable delay before information leaks occur. This leaves the spur to activity without hint as to the proper direction. In the industrial field, however, the industrial instrument must be sold in the open marketplace; technical information in one way or another soon becomes available to competitors.

All fields of instrumentation have benefited technically by the wide dispersion of contracts for aviation instruments. Firms with small engineering staffs have generally concentrated on making aviation instruments developed largely by others. The benefit has come from the necessity for high quality in materials and performance, strict inspection, and multitudinous requirements above those for industrial instrumentation. This undoubtedly has raised the technical level of similar industrial instrumentation.

Continual improvements in, and additions to, aviation instrumentation have been made necessary (a) by the continual increase in aircraft speeds and accelerations, (b) by the increasing altitude of aircraft operation, (c) by conditions encountered in flight and storage in desert, tropics, and polar regions, (d) by the change from piston to jet engines, (e) by the increase in the size of aircraft, (f) by the need to simplify overly complex operations required of the pilot and (g) by the advent of the helicopter and guided missile.

Owing to the impact of these new developments, aviation instrument engineers have had no chance to rest on their oars. A few of the instrument performance requirements made necessary are (a) increased accuracy (always stretched to the limit of the attainable), (b) functioning over an increased temperature range, both hot and cold, (c) protection against dust and corrosion, and (d) functioning independently of much higher accelerations. Systems engineering, originally developed for other applications, has been applied to the design of automatic pilots, automatic controls for navigation, and to other operations on aircraft, notably the powerplant.

Although raising no severe instrument problems directly, cabin pressurization and ejection seats have required major redesign of the oxygen supply apparatus for the flight personnel in order to increase safety.

The complexity of the pilot's duties has drawn attention to the need for simplifying the entire instrument indication structure. Dial and pointer design, and combination of the indication of many instruments, possibly pictorially, are receiving serious attention from both instrument engineers and psychologists. One development in the direction of simplification is the "Zero Reader," with others presumably in the offing. Methods of lighting instrument dials and panels are under continuous development to meet new requirements or to remedy defects.

In navigation, substantial improvements have come slowly. For indicating direction and control of flight, gyroscopic instruments are greatly improved in accuracy and reliability. Remote indication wherever possible is of necessity favored; it is highly developed in indicating direction, and is in sight for indicating the vertical.

One of the difficulties facing engineers is the lack of published basic information on aviation instruments. Where this condition is obviously due to world conditions, it is fair to ask whether the degree to which secrecy is practiced may hinder more than it benefits the country. This can be answered only by considering particular cases. Knowledge sharing cannot be expected under severe competitive conditions.

For example, consider the unglamorous primary measuring elements and basic components, such as resistance thermometers and helical springs, which must be made by each manufacturer because they cannot be bought. Basic design data and techniques of construction are often not available in the instrument literature or handbooks, although well known to the engineers of firms with experience. Each newcomer, whether young or old, must here

*Retired Chief, Mechanical Instruments Section, National Bureau of Standards

start from scratch. This is not only an economic waste but, in aviation instrumentation, also possibly an ultimate hazard. A good case can be made for making available to all instrumentation engineers technical information on components such as helical springs or resistance thermometers.

I wish to direct attention particularly to pressure-sensitive elements—the Bourdon tube and the corrugated diaphragm and capsule. Possibly the slack diaphragm should be included, although it is not widely used in aviation instruments. The lack of information on corrugated diaphragms is in a fair way to be remedied by research supported in the dim past jointly by the N.A.C.A. and the National Bureau of Standards, more recently by the Signal Corps Laboratories, and now by the Air Force Research and Development Command. The program being undertaken by the ASME Research Committee on Mechanical Pressure Elements should be mentioned also.

There are many other measuring elements on which research is needed, even though considerable basic data are available. Examples are temperature elements for measuring jet-engine temperature, and fuel-flow measuring elements. Although not measuring elements, pivots and bearings are an important example of another class on which basic design and performance data under severe operating conditions could be obtained with profit.

Research along the various lines outlined has little glamor and holds little promise for quick spectacular results, yet is essential to improvement in aviation, perhaps all, instrumentation. Availability of the results must not be overlooked.

Analytical Instrument Clinic

The Instrument Society of America announces plans for the Third Analytical Instrument Clinic to be held in conjunction with the First International Instrument Conference and Exhibit at Philadelphia, September 13-25, 1954. The Clinic will be held on September 13, 14, and 15.

The Clinic is a lecture and demonstration course on the latest and most advanced analytical instruments. It is planned for technicians, engineers, physicists and chemists who are using or who contemplate using these instruments.

The participating companies and the instruments to be demonstrated are: X-Ray Quantometer—Applied Research Laboratories; Littrow-Echelle Spectrograph—Bausch & Lomb Optical Company; Infrared Spectrometer—Beckman Instruments, Inc.; Process Monitor Mass Spectrometer—Consolidated Engineering Company; Ion Resonance Mass Spectrometer—General Electric Company; Non-dispersion Infrared Analyzers—Liston-Becker Instrument Company; and Nuclear Magnetic Resonance Spectrometer—Varian Associates.

A three-hour session on each instrument will be conducted by two or more experts and will cover the theory of the instrument, electronic, optical and mechanical design features, as well as details of application.

Advance registration is required. Any number of sessions, up to five, may be attended. The sessions on each instrument will be small and will be repeated up to a maximum of five times. For registration forms and further information write to Dr. Axel H. Peterson, Mellon Institute, 4400 Fifth Avenue, Pittsburgh 13, Pennsylvania.

CORRECTION

In the article "Periodicals on Instrumentation" which ran in the May, 1954 issue of *Instruments and Automation*, the date of the first issue of the *Journal of Scientific Instruments* was reported incorrectly. The actual year of the first issue was 1923.

A letter to the editor

Dear Sir:

We are much perturbed by certain passages in an article by Mr. Jay Dobrin entitled "Use and Maintenance of the A-C Vacuum-tube Voltmeter" appearing in your February 1954 issue, Vol. 27, No. 2, pp. 288-301. A certain statement therein reflects adversely on a type of voltmeter manufactured and sold by this company, and having full cognizance of the condition described, we feel that the criticism is not only unjustified but that it regrettably misleads prospective users of our products into the belief that they are unreliable and inaccurate.

Particular reference is made to statement 6 under the section headed "VTVM Circuit" on page 289 which reads:

"At the extreme low end of the scale there is little torque, either electrical or spring torque, to overcome friction in the meter bearings."

Now it is true that at the low end of the scale the torque in a shaded-pole (and also in a uniform-pole) indicating instrument is low as compared to that obtaining at full scale. But in a high-quality logarithmically graded instrument, such as we procure from one of the most reputable meter manufacturing concerns in this country—namely the Weston Electrical Instrument Corporation—adequate torque is engineered into the design to insure that the friction effect may not exceed ½ degree of scale arc. This is, indeed, our specification for the maximum allowable friction influence at mid-scale including the effect of pivot roll, and owing to the fact that our vendor attempts to provide a margin to minimize rejects we find that this specification is consistently met at the lowest scale reading also.

The above-mentioned magnitude of friction influence in a logarithmic instrument meter having a 90-degree arc and covering a range of 10 to 1 between full-scale and low-scale volts, such as applies to our instruments, results in a maximum possible indeterminancy of 1.25 percent in making a voltage reading, regardless of the pointer position on the scale. This condition exemplifies one of the major advantages of the logarithmic indicating instrument over a linear instrument having uniform pole pieces when applied to the type of voltmeter under consideration. The figure of ½ degree for friction influence is commonly accepted as a commercial tolerance for linear meters also. Thus for a linear meter having a scale arc of 90 degrees the friction error, while being 0.55 percent at full scale, would be 1.1 percent at mid-scale and 1.83 percent at 30 percent of full-scale reading such as must be made on occasion in certain types of vacuum-tube voltmeters manufactured by some other companies. Worse still, in order to cover the full range claimed by the latter, it is necessary to read the lowest voltage at 10 percent of full-scale, when the friction influence could approach 6 percent.

Other advantages accruing from the use of a logarithmic indicating instrument include the avoidance of multiple voltage scales, the availability of a linear decibel scale and, for readings below half full-scale, improved readability and smaller parallax errors. However, an elaboration of these points is not pertinent to our grievance except insofar as they may serve to offset further the unfounded criticism of the logarithmic type expressed by Mr. Dobrin in his article.

WALTER KRAM
Chief Engineer,
Ballantine Laboratories, Inc.

Don't forget—
THE FIRST INTERNATIONAL AUTOMATION EXPOSITION
244th Coast Artillery Armory,
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For more information circle 36 on inquiry card.

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 983

TEMPERATURE

Portable Potentiometer

New "Series 300 Portable Potentiometer" affords improved flexibility for checking and calibrating temperature measurement and control instruments; is suited for precise laboratory work as well as for maintenance and service work in the plant or field. Forty-inch scale is readable to 0.025 mv. Built-in thermometer for measuring cold junction temperatures. Six standard models.—*Wheelco Instruments Div., Barber-Colman Co., Rockford, Illinois.*

For more information circle **201** on inquiry card.

Pyrometers

New models of maker's "Simplytrol Controls" and indicating pyrometers include ten new ranges: now eighteen ranges cover from −400 to 3000 F.,

all with corresponding C. Several suppressed-zero scales are included. All ranges have bimetal compensation on cold junction.—*Assembly Products, Inc., P. O. Box* 191, *Chagrin Falls, Ohio.*

For more information circle **202** on inquiry card.

Resistance Thermometers

New strain-free platinum resistance thermometers are said to be standards for measurements of highest precision and accuracy, such as calibration of other thermometers, measurements of freezing and boiling points, and calorimetry. Range:—183 C. to 500 C. Thermometers comply with requirements of 1948 International Temperature Scale; are calibrated by National Bureau of Standards when customers so desire. Pyrex stems have a standard length of 18 in. (as short as 5½ in. to order). Resistance is approx. 25.5 ohms at 0 C. Length of platinum wire is adjusted to 10 ohms change between 0 C. and 100 C. Aluminum head; four internal leads in the form of a single cable 8 ft. long, separated near its end into four leads each fitted with a gold-plated copper terminal.—*American Instrument Co., Silver Spring, Md.*

For more information circle **203** on inquiry card.

Double-bore Thermowells

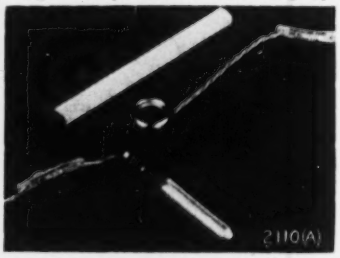
New "Double-Bore Wells" minimize error sources in temperature instrument test procedures; permit accurate

tests without removing detecting element from well; obviate need of separate test wells; reduce cost of test procedures.—*Trinity Equipment Corp.,* 472 *Westfield Avenue, East, Roselle Park, N. J.*

For more information circle **204** on inquiry card.

Thermometric System

New temperature measuring system provides signal voltages sufficiently high to operate telemetering sys-



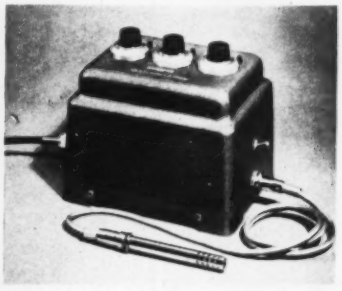
tems, recorders and oscillographs without amplifying equipment. "Temperature Probes" (Fig. A) are high-speed resistance-thermometer elements; range −70 F. to 500 F.; models for surface, liquid, and gas tempera-

ture measurements. "TME-25 Balance and Power Unit" (Fig. B) contains circuitry for 24 temperature probes plus one reference channel; range and sensitivity adjustments for each measuring channel whereby all types of telemetering signal inputs can be supplied. Units for more or fewer measurements available.—*Arnoux Corp.,* 1357 *S. Hawthorne Blvd., Hawthorne, Calif.*

For more information circle **205** on inquiry card.

Thermometric Bridge

New "S-81600 Thermometric Bridge" has thermistor primary element and detachable shielded cable.

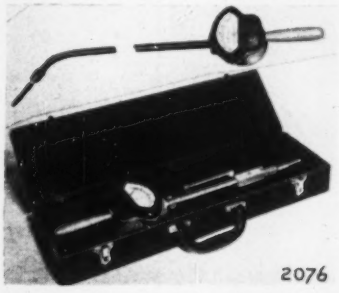


When used with galvanometers of moderate sensitivity or recorders having full-scale equivalents of a few millivolts, a measuring precision of several thousandths of a Centigrade degree is practicable over range of 0 to 100 C.—*E. H. Sargent & Co.,* 4647 *W. Foster Av., Chicago* 30, *Ill.*

For more information circle **206** on inquiry card.

Portable Pyrometers

New immersion and surface type pyrometers incorporate new features; example, extra-heavy high-tempera-



ture Transite tip on button type surface pyrometer is practically accident-proof and can be inexpensively replaced. Four models: #22-B button type surface pyrometer; #22-R roll type for rotating surfaces; #22-H hypodermic type for soft material; #22-I immersion type. All models have heavy aluminum handles with extra-heavy Bakelite shatter-proof fan-shaped doubly compensated indicators.—*Pyrometer Service Co. Inc.,* 348 *River Road, North Arlington, N. J.*

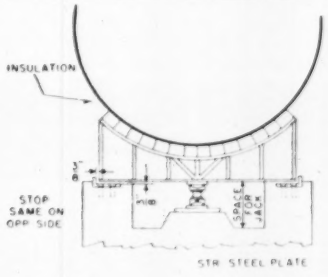
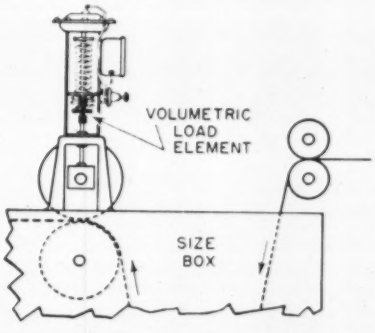
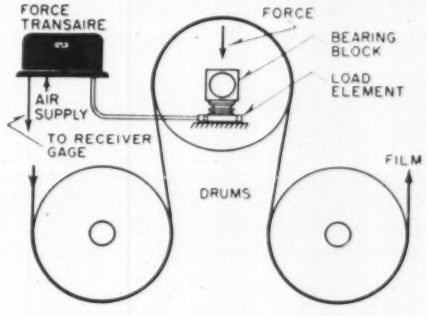
For more information circle **207** on inquiry card.

Thermistor Kits

Two new kits enable scientists and engineers to conduct exploratory studies in adapting thermistors. Kit No. 1 includes 18 thermistors, two of each

Let us take a load off your mind!

DO YOU have a tricky load measurement problem on your mind? Something like measuring the tension on a conveyor belt for example, or the thrust on a bearing, or the weight of solids or corrosive liquids in a tank . . . ? Taylor volumetric load measuring elements have been used for years in paper mills, but there are many applications throughout the industry where these highly accurate and sensitive instruments are proving invaluable. Most recent developments afford a wide variety of ranges, greater range suppression, greater over-range protection and greater energy for positioning the pen or actuating a control mechanism. Applicable to tension and compression loads. Call your Taylor Field Engineer or write for **BULLETIN 98232.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

PROBLEM	SOLUTION	CHARACTERISTICS
To accurately measure the weight of chlorine in tanks		**Spool type Load Measurement Element** **Range limits:** 0-240,000 lbs. for compression loads, maximum load not to exceed 400,000 lbs. Applicable to horizontal or vertical tanks, containing corrosives or solids, making conventional level measuring devices impractical. Tension loads 0-30,000 lbs.
To accurately measure squeeze roll pressures on textile slashers		**Diaphragm type Load Measuring Element** **Range limits:** 0-5,000 lbs., maximum load not to exceed 6250 lbs. Compound ranges, tension—0—compression also available. Applicable to measure roll or nip pressures in calender stacks, press section and many other finishing operations involving processing of material between rolls.
To measure film tension within very close limits as a measure of "gain" or percentage of stretch		**Transaire Volumetric Load Measuring Element** **Range limits:** 0-300 lbs. in range spans as short as 30 lbs. Used in conjunction with a TANSAIRE* Pressure Transmitter which sends an output air pressure to an indicating, recording or controlling receiver proportional to the force applied. Applicable to film, paper, yarn or similar tension measuring requirements.

*Reg. U.S. Pat. Off.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

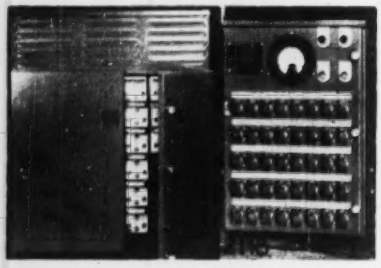
For more information circle **37** on inquiry card.

in three styles and three sizes, segregated in a compartmented drawer of imitation leather container. Kit No. 2 consists of a metal container with four drawers, segregating 104 thermistors into 26 sizes and four styles; also contains assorted steel, lead and fiber washers and tubing.—*Carboloy Dep't, General Electric Co., Detroit 32, Mich.*

For more information circle **208** on inquiry card.

Bearing-temperature Monitoring System

New "Continuous Bearing Temperature Monitor" system enables operator to maintain a continuous and automatic watch on bearing temperatures

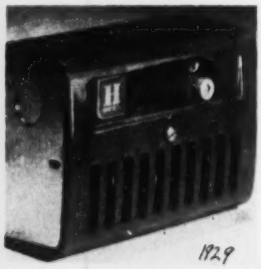


throughout the ship in which it is installed. Left, "Thermocouple Amplifier"; right, 'Scanner Unit."—*Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson 3, N. J.*

For more information circle **209** on inquiry card.

Heavy-duty Thermostat

New heavy-duty thermostat, for areas where dust, corrosion and humidity are a problem, features corrosion-resistant parts, sealed Micro

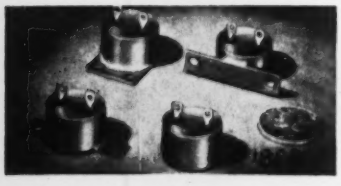


switch contacts, and thermal element coiled within cover. Switching action is provided so that it can also be used to regulate building ventilating systems.—*Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*

For more information circle **210** on inquiry card.

Sealed Thermostat

New "Stemco Type A" hermetically-sealed thermostats employ a disk type bimetal thermal element for

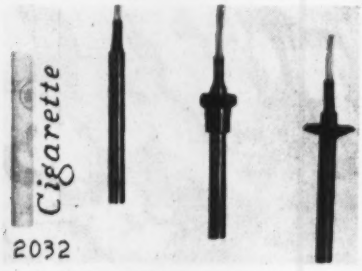


quick make and break operation. Among features is an insulated electrically-independent bimental that eliminates false cycling and life-shortening "jitters." Wide variety of mounting arrangements. Maximum operating temperature 300 F.—*Stevens Mfg. Co., Mansfield, O.*

For more information circle **211** on inquiry card.

Midget Thermostat

New "Midget Thermoswitch" is said to feature built-in temperature anticipation, fast reaction time, short heat transfer path, wide operating range,



uniform sensitivity, and resistance to shock and vibration. Unit is factory set to actuate at any selected temperature between −65 and 450 F.; 1-amp. rating at 115 v.ac. or 32 v.dc. Three models permit various mounting arrangements.—*Fenwal Inc., Ashland, Mass.*

For more information circle **212** on inquiry card.

Appliance Thermostat

New "Model R-6" conduction type thermostat features heat-sensitive element within brass channel section of case. Heat transferred over entire area of base makes it suitable for appliances where fast heating and close control are essential. One-hole mounting (side mounting also available). Rating 115-230 v.ac. only;

wattages up to 2000 depending on application. Control shaft 1¼ in. minimum to 2 in. maximum. Range 70 to 650 F.; calibrates from "off" to 525 F. with knob rotation of 310 deg. —*American General Thermostat Corp., 2066 Bronx St., New York 60, N. Y.*

For more information circle **213** on inquiry card.

Thermistor Package

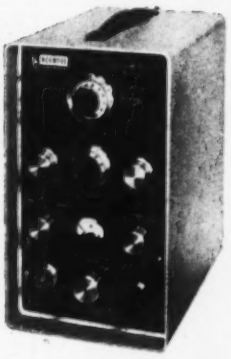
New "show-window" method of packing thermistors permits quick, positive identification; also provides increased product protection.—*Carboloy Dep't, General Electric Co., Detroit 32, Mich.*

For more information circle **214** on inquiry card.

PRESSURE AND VACUUM

Pressure Monitor

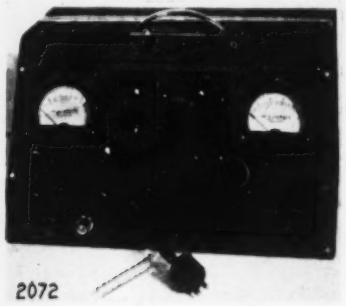
New "5AC Pressure Monitor," for use with any 2- or 4-arm strain-gage pickup and standard oscilloscope, provides a calibration system yielding pressure indications in psi. when pickup sensitivity is known in terms of microvolts per volt per psi. Its calibration circuit allows static as well as rapidly-fluctuating pressures to be measured accurately. Amplification is 100 with high degenerative feedback, usable from 0.3 to 50,000 cps. Effective shock mounting is said to reduce microphonics to a negligible level. User can observe pressure fluctuations as low as 0.1 percent of full scale.—*Control Engineering Corp., 560 Providence Hwy, Norwood, Mass.*



For more information circle **215** on inquiry card.

Vacuum Gage

New "Model 505" vacuum gage can be used with practically any filament-type standard ionization tube or with

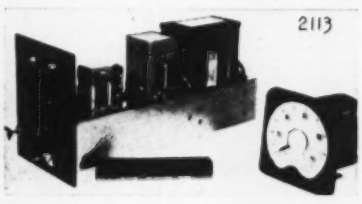


maker's "G-24" shown in illustration. Three standard ranges: 10^{-4}, 10^{-5} and 10^{-6} mm. Hg; other ranges available. —*Philadelphia Scientific Glass Co., 4 Eckard Ave., Abington, Penna.*

For more information circle **216** on inquiry card.

Amplifier for Pressure and Load Cells

New "PTL" is a low-cost amplifier for indicating (on most 5-v.-scale voltmeters) the forces, weights, or pressures measured by means of maker's "SR-4" load cells and pressure cells;



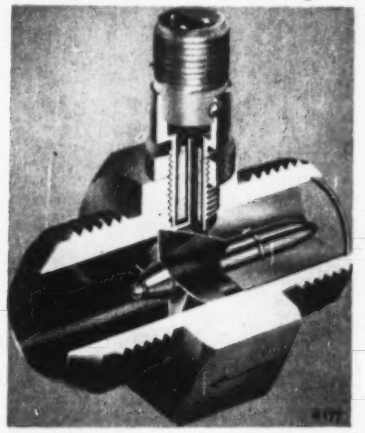
operates on 115 v.ac. through a built-in regulated power supply; incorporates a premium-version high-mu twin triode operated well below rating. Panel mounting units, as shown, or single and multiple units in a case. —*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **217** on inquiry card.

FLOW-RATE

Flow-rate Pickups

New "Series FL" turbine-type flow pickups cover flow rates from 0.3 to 3000 gpm. Fluid flow drives a freely-spinning turbine wheel, which gener-

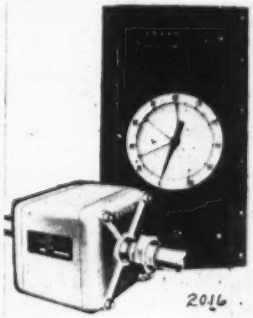


ates pulses in an externally mounted magnetic coil. Pulse frequency is used as a measure of flow rate; total number of pulses measures total volume of fluid. Accuracies of 0.5 percent at pressures to 3500 psi., temperatures from −300 F. to 800 F. and "under severe shock and vibration."—*Waugh Engineering Co., 15306 Dickens St., Sherman Oaks, Calif.*

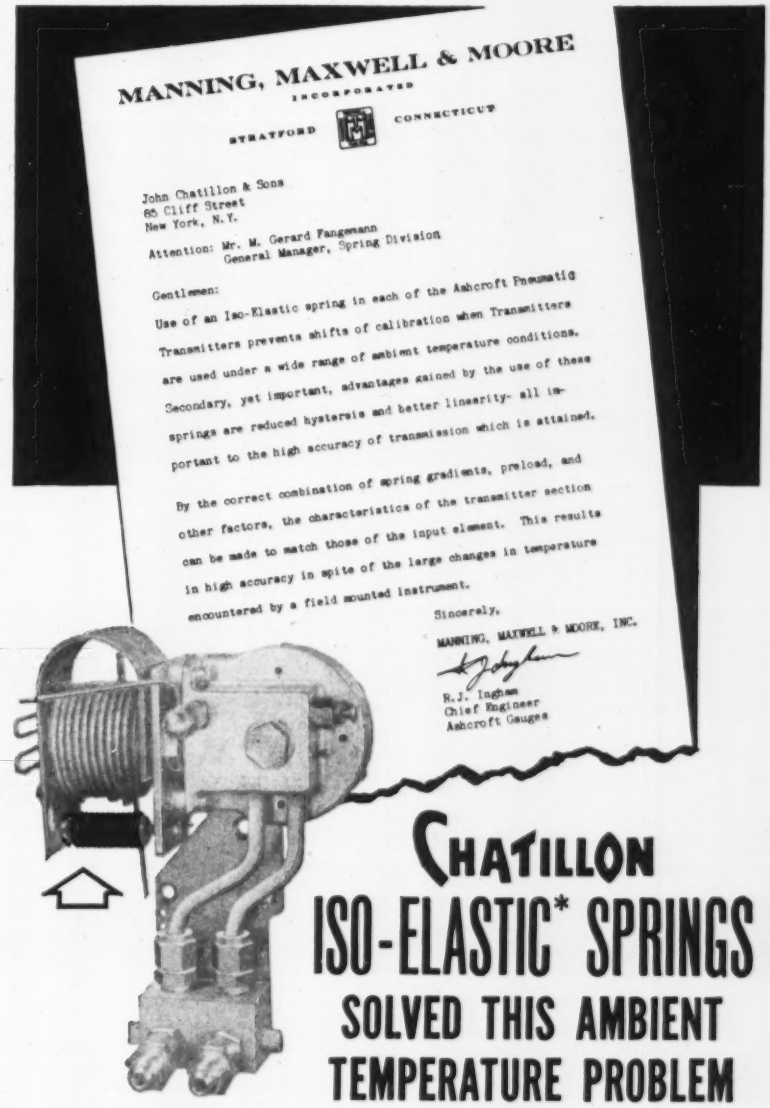
For more information circle **218** on inquiry card.

Magnetic Flowmeter

New "Figure 950 Xactronic" is an electromagnetic flow meter for conducting liquids: water and aqueous



solutions, acids, slurries, emulsions, molten salts, liquid metals, etc. High pressures and temperatures or a high concentration of suspended matter present no obstacle. Metering element is an enclosed-magnet stainless-steel tube with teflon liner and attached electrodes connected to remote indicator or recorder. It has no moving parts, cannot be clogged, and pressure drop through it is no more than


MANNING, MAXWELL & MOORE
INCORPORATED
STRATFORD CONNECTICUT
John Chatillon & Sons
65 Cliff Street
New York, N.Y.
Attention: Mr. M. Gerard Fangemann
General Manager, Spring Division
Gentlemen:
Use of an Iso-Elastic spring in each of the Ashcroft Pneumatic
Transmitters prevents shifts of calibration when Transmitters
are used under a wide range of ambient temperature conditions.
Secondary, yet important, advantages gained by the use of these
springs are reduced hysteresis and better linearity- all im-
portant to the high accuracy of transmission which is attained.
By the correct combination of spring gradients, preload, and
other factors, the characteristics of the transmitter section
can be made to match those of the input element. This results
in high accuracy in spite of the large changes in temperature
encountered by a field mounted instrument.
Sincerely,
MANNING, MAXWELL & MOORE, INC.
R.J. Ingham
Chief Engineer
Ashcroft Gauges

CHATILLON ISO-ELASTIC* SPRINGS SOLVED THIS AMBIENT TEMPERATURE PROBLEM

Ashcroft Pneumatic Transmitters made by Manning, Maxwell & Moore, Inc., operate within a wide range of temperatures—a condition requiring an unusual type of precision spring performance. Making use of its revolutionary "Iso-Elastic" material, Chatillon designed and supplied the springs used exclusively in these gauges, thereby insuring the best hysteresis and linearity characteristics.

Chatillon "Iso-Elastic" is a temperature-compensated alloy that is virtually unaffected by temperature changes. Developed by John Chatillon & Sons with the assistance of Professors A. V. de Forest of M.I.T. and F. Sayre of Union College, it has obtained universal recognition in the instrument field for utmost strength and linearity, extremely low hysteresis and drift. These factors combine to make Chatillon "Iso-Elastic" springs the finest and most accurate obtainable.

Consult the Chatillon Spring Division for assistance in improving the accuracy of your present springs. Enigneering bulletins on "Iso-Elastic" alloy and springs are available upon request.

*U.S.A. PAT. No. 2174171

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK, N.Y.
Manufacturers of Precision Springs and Measuring Apparatus Since 1835

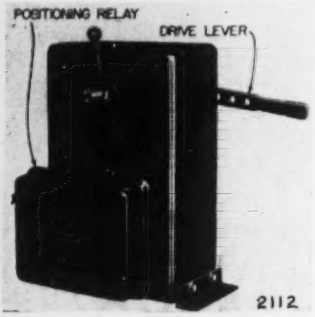
For more information circle **38** on inquiry card.

through an equivalent length of pipe. Accuracy is rated at 1 percent of full-scale reading, but under appropriate conditions 0.5 percent can be obtained. Accuracy is not affected by changes in liquid viscosity, density, temperature; by transition from laminar to turbulent flow; or by line voltage fluctuations. Instrument scale is linear. Meters are available in six sizes from ½-in. to 2-in., to indicate fluid quantity, to indicate flow-rate, to record flow-rate; for combined functions; or with a pneumatic or electric controller to control flow-rate.—*Bowser, Inc., Fort Wayne 2, Ind.*

For more information circle **219** on inquiry card.

Flow-control Power Unit

New air-operated "Control Drive" improves gas and liquid flow regulation; permits butterfly valves, dampers, feeders, etc., to be operated on a straight-line flow characteristic. A pneumatic signal (3-15 or 3-27 psi.) actuates a positioning relay which in turn positions a piston-operated drive lever arm. Three different characteristic cams are supplied and may be shaped if necessary. Time required for full travel (75 deg.) is adjustable. Unit has a 4-in. piston stroke at a torque of 75 lb.-ft. Available from stock.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*



For more information circle **220** on inquiry card.

SPEED

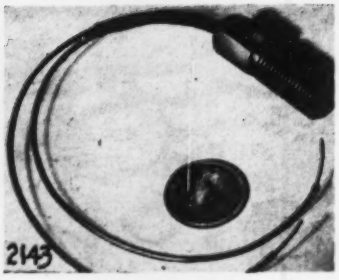
Motor Control Systems

New "Electronic Variable Speed Motor Control Systems" are completely redesigned; are available from 1/15 hp. to 3 hp.; feature critical component plug-in assemblies. New electrical design utilizes motor series field as a torque signal source in a new feedback circuit to provide constant system torque capability. Controlled acceleration on many models allows use in applications of high-inertia loads without placing excessive torque load on materials in critical processes.—*Brown-Brockmeyer Co., Dayton, Ohio.*

For more information circle **221** on inquiry card.

Magnetic Pick-up

New "Model 3015" miniature pick-up produces an alternating voltage proportional to speed of moving metal object in its field (no mechanical contact), weighs 1/3 oz. or 1/30 of maker's standard "3010-A." Resonant frequency 60 kc.; impedance 500 ohms at 1000 cps.—*Electro Products Labs., Inc., 4501 N. Ravenswood Ave., Chicago 40, Ill.*



For more information circle **222** on inquiry card.

Stroboscopic Lamp

New "Model H Strob-Light," for checking speeds of rotating equipment and calibrating tachometric devices, checks speeds at sixteen intervals between 450 and 3600 rpm. and ten additional intervals to 6000 rpm.; operates on 115-v.ac. 60-cps.; can be used by unskilled personnel.—*George L. Nankervis Co., 19255 W. Davison, Detroit 23, Mich.*

For more information circle **223** on inquiry card.

TIME AND COUNT

Coded-signal Receiver

New "Coded Signal Receiver" extends automatic operation of signals, relays, switches, etc., in remote locations according to preselected programs. Receivers are controlled by code pulses transmitted over regular ac. line when used with an "IBM Electronic Time and Program Control System" and by electrical impulses when used with wired time systems. Code pulses are transmitted automatically to individual receivers. First code pulse actuates a code selector mechanism in all receivers tuned to frequency being transmitted; second pulse selects those units which are to function; time interval between pulses determines which receivers will operate. Signal duration is pre-set in each receiver. Any one of four frequencies can be selected for transmission in a given minute and up to eight basic circuits (including a clock correction circuit) can be supervised on each frequency from a single transmitter.—*International Business Machines Corp., 590 Madison Avenue, New York 22, N. Y.*

For more information circle **224** on inquiry card.

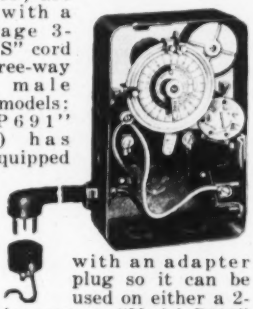
Automatic Timers

New electronic timers have "Percent On" time variable from 25 to 75 percent. "Cycles Per Minute" likewise is continuously variable. Either may be changed without disturbing the other and may be adjusted with equipment in operation. "Model T-1" covers a frequency range of 10 to 50 cycles per minute and "T-2" is a dual range model with a total frequency coverage from 2 to 100 cycles per minute.—*Mt. Sopris Instrument Corp., 1320 Pearl St., Boulder, Colo.*

For more information circle **225** on inquiry card.

Skipper Time Switches

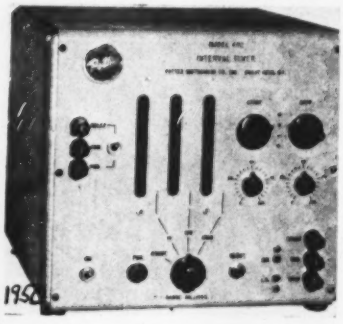
New "Series P690" portable plug-in time switches will control automatically any ⅓, ½, ¾, or 1-hp. room air conditioner; are equipped with a 4-ft. 14-gage 3-wire type "S" cord set with three-way grounded male plug. Two models: "Model P691" (125-volt) has cord set equipped with an adapter plug so it can be used on either a 2-wire or 3-wire system. "Model P692" is for 250-volt 3-wire electrical systems. Both incorporate "Inter-Matic" skipping device which permits user to skip automatic operation on Saturdays, Sundays, holidays, etc. Up to eleven on-off operations per day. Approved by Underwriters Laboratories.—*International Register Co., 2624 W. Washington Blvd., Chicago 12, Ill.*



For more information circle **226** on inquiry card.

Timer and Counter

New "Model 432 Interval Timer," for measuring short time intervals, has three ranges: 0.01-9.99, 0.1-99.9, and 1-999 msec.; also serves as a high-speed totalizing counter with a count capacity of 999, and as a secondary frequency standard with outputs of



100, 10 and 1 kc., and 100, 10 and 1 cps. All time-base signals originate in a 100-kc. crystal-controlled oscillator. —*Potter Instrument Co., Inc.*, 115 *Cutter Mill Rd., Great Neck, L. I., N. Y.*

For more information circle **227** on inquiry card.

Multiple-unit Counters

New models of "Vary-Tally counter for quality control, inventory control, laboratory analysis, etc., are available

2097

in 66 combinations, up to 6 banks high and 12 units wide (minimum 2 units wide). Fingertip pressure on front lever of a unit registers to 9999. A reset knob returns all counters in any tier to zero. Name, size, etc., of item to be counted is inserted in a panel over reading line on each "Vary-Tally."—*Veeder-Root, Inc., Hartford 2, Conn.*

For more information circle **228** on inquiry card.

COMPUTING

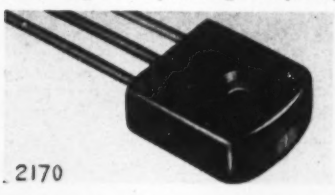
Analog Computer

New "Model 30 Analog Computer" contains ten stable high-gain amplifiers, regulated power supply, and provision for applying five independent initial-condition voltages. It is capable of solving most constant-coefficient differential equations of both linear and non-linear types encountered in engineering. Features: Plug-in printed circuit problem boards; schematic style layout of amplifier and initial-condition connections facilitate rapid problem set-up.—*Donner Scientific Co., 2829 Seventh St., Berkeley 10, Calif.*

For more information circle **229** on inquiry card.

Computer Read-record Head

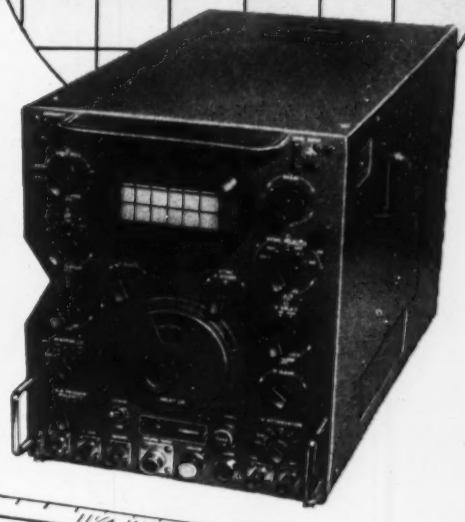
New recording head, for recording and reading binary data on magnetic drum memory systems in digital computers, consists of a center-tapped toroidally wound coil, molded in moisture-proof epoxy resin; features a new-type 1-piece ferrite core. Elimination of back-gap, reduction of size of front-gap to 0.0015 in., and use of a low-distributed capacitance winding, are said to result in less core reluctance, higher operating frequency,



2170

SAR PULSESCOPE

by Waterman



MODEL S-4-C

DIRECT-READING
DELAYED SWEEP
ACCURATE TO
0.1%

Size:
9⅛" x 11¼" x 17¼"
31.5 Pounds

ANOTHER EXAMPLE OF Waterman PIONEERING...

The SAR PULSESCOPE, model S-4-C, is JANized (Gov't Model No. OS-4), the culmination of compactness, portability, and precision in a pulse measuring instrument for radar, TV and all electronic work. An optional delay of 0.55 microseconds assures entire observation of pulses. A pulse rise time of 0.035 microseconds is provided thru the video amplifier whose sensitivity is 0.5V p to p/inch. The response extends beyond 11 mc. A and S sweeps cover a continuous range from 1.2 to 12,000 microseconds. A directly calibrated dial permits R sweep delay readings of 3 to 10,000 microseconds in three ranges. In addition, R sweeps are continuously variable from 2.4 to 24 microseconds; further expanding the oscilloscope's usefulness. Built-in crystal markers of 10 or 50 microseconds make its time measuring capabilities complete. The SAR PULSESCOPE can be supplied directly calibrated in yards for radar type measurements. Operation from 50 to 400 cps at 115 volts widens the field application of the unit. Countless other outstanding features of the SAR PULSESCOPE round out its distinguished performance.

WATERMAN PRODUCTS CO., INC.
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CABLE ADDRESS: POKETSCOPE

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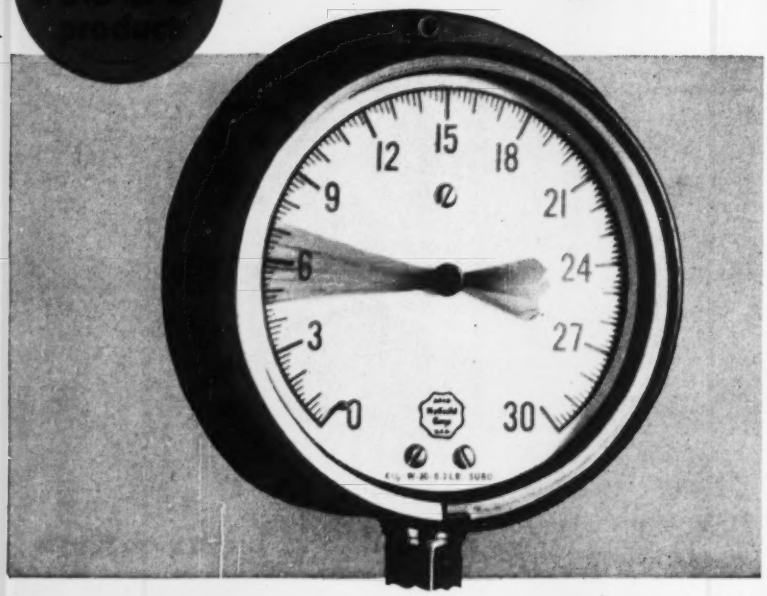
S-4-C SAR PULSESCOPE®
S-5-A LAB PULSESCOPE
S-6-A BROADBAND PULSESCOPE
S-11-A INDUSTRIAL POCKETSCOPE®
S-12-B JANized RAKSCOPE®
S-14-A HIGH GAIN POCKETSCOPE
S-14-B WIDE BAND POCKETSCOPE
S-15-A TWIN TUBE POCKETSCOPE
RAYONIC® Cathode Ray Tubes
and Other Associated Equipment

For more information circle **39** on inquiry card.

Helicoid Gages



Flutter Won't Hurt Them!

HELICOID Gages are designed to withstand many millions of pressure pulsations. Flutter and rapid surges have no effect on their accurate performance in long-life service. Tests show 75,000,000 cycles at 1200 pulsations per minute without wear.

1. There are no gears to wear out

Only HELICOID Gages offer this long-lasting gage movement. There are no gears, no teeth to wear out. Cam wiping action keeps contact points clean and smooth.

2. Bourdon tubes won't stretch, leak or crack

Bourdon tubes in HELICOID Gages give maximum torque and minimum stress to promote greatest possible endurance life. Will withstand millions of pressure pulsations without stretching, leaking or cracking.

HELICOID Gages for Pressure, Vacuum or Compound Service

There are HELICOID Gages for all pressure ranges —with white, black or radiant faces—wall, stem, flush and panel mountings for flangeless cases. See your distributor today or write for **Catalog G-2.**

ACCO

Helicoid Gage Division
AMERICAN CHAIN & CABLE

927 Connecticut Avenue • Bridgeport 2, Connecticut

For more information circle **40** on inquiry card.

greater reliability and sensitivity of read-back voltage, and improved temperature stability. Resonant frequency is 500 kc. and crosstalk is —60 db for adjacent heads.—*Librascope, Inc.*, 1607 *Flower St., Glendale, Calif.*

For more information circle **230** on inquiry card.

NUCLEONICS

Liquid Sample Counter

New "SC-12 Liquid Sample Attachment," incorporated with "SC-3 Basic Unit" and "LH-6 Lead Shield," was designed for counting low-level activity in small-volume liquid samples (up to 5 cc). When used with "LH 6 Shield," background is reduced to approx. 200 counts per minute while giving sensitivity of 1000 cpm. for one millimicrocurie of I-131: estimated efficiency 50 percent of all gamma rays emitted.—*Nuclear Research and Development, Inc.*, 6425 *Etzel Ave., St. Louis* 14, *Mo.*

For more information circle **231** on inquiry card.

Scintillation Spectrometer

New "Model 2300" is said to be "the first completely automatic scintillation spectrometer." Once system is set into operation, it automatically sweeps between any two predetermined levels within its range of 0 to 100 volts, then resets and repeats cycle. Equipment consists of: "Model 118 Electronic Sweep and Count Rate Computer" (top), "Model 115 Pulse Height Analyzer" (middle), "Model 80 Precision High Voltage Supply," "Model 43 Scintillation Counter," and Brown "Electronik" recorder. Each of these units is available separately and may be operated separately. Front panel switches provide selection of slow or fast electronic sweep and count rate sampling time.—*Radiation Instrument Development Lab.*, 2337 *W. 67th St., Chicago* 36, *Ill.*

For more information circle **232** on inquiry card.

Well-type Scintillation Counter

New "DP4" is constructed so that probe assembly may be used separately. Probe will accept any type of crystal. Photomultiplier tube is Dumont 6292 with a 6AK5 cathode-follower, surrounded with 2 in. of virgin lead, baked-on white enamel for easy decontamination. All metal parts of probe also easy to decontaminate. Immediately available.—*Detectolab, Inc., 6544 N. Sheridan Rd., Chicago 26, Ill.*

For more information circle **233** on inquiry card.

Scintillation Survey Meter

New "Model 389-F" high-sensitivity gamma reduction survey meter weighs 7½ lbs.; features a compact scintillation probe clamped in handle of rugged watertight instrument case.

For laboratory, ground or aerial surveys requiring maximum sensitivity, scintillation detector has up to 20 times efficiency of Geiger tube detectors. Calibration is in counts per minute, or milliroentgens/hour on request. Also available with an Alpha detector head.—*The Victoreen Instrument Co., 3800 Perkins Ave., Cleveland 3, Ohio.*

For more information circle **234** on inquiry card.

OPTICS

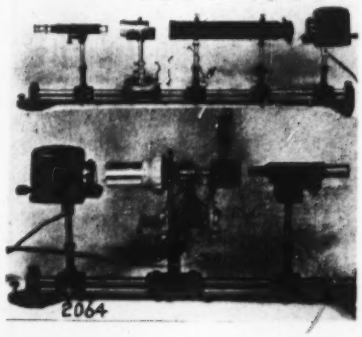
Microscope and Projector

New "Micro-Viewscope" combines a microscope (75X and 500X) with enclosed illuminating and projection elements having an 8-in. ground glass screen on a sloping desk; is also equipped for photomicrography.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

For more information circle **235** on inquiry card.

Optical Bench

New "Universal Instrument Bench" for proving out and testing instrumentation systems permits thousands



RELAYS THAT FIT

electrically

mechanically

costwise

Over 5,348 standard Struthers-Dunn relay and timer types—each designed for a specific purpose—spell maximum efficiency and economy for the great majority of applications.

Equally important, more than 30 years of specialization in relays exclusively, means that Struthers-Dunn is uniquely fitted to recommend as well as to supply types that fit your particular application like the proverbial glove.

S-D STRUTHERS-DUNN, INC.

STRUTHERS-DUNN

NEW ADDRESS

OVER 5,348 RELAY TYPES

STRUTHERS-DUNN, INC., LAMB'S ROAD, PITMAN, N. J.

ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
CLEVELAND • DALLAS • DETROIT • KANSAS CITY • LOS ANGELES
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ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

For more information circle **41** on inquiry card.

of set-ups to be made by choosing from over 50 available components and assembling them in various combinations; can be utilized in research and development lab, production line, in assembly and inspection and for 30X photographic enlargements.—*Meyer-Opticraft, Inc., 39 W. 60th St., New York 23, N. Y.*

For more information circle **236** on inquiry card.

Long-distance & Erecting Microscope Attachment

New microscope attachment (English-made) provides 12.8 mm. working distance; also erects image viewed; operates well under phase-contrast procedures; will fit any standard microscope. It replaces one of the objective lenses and revolves readily. Heart of system is a half-aluminized plate which first passes light rays then, when they are reflected back to it by a first-surface mirror, reflects lights rays correctly positioned for viewing by objective. Unit is available in two sizes: 40X with f/1 of 4 mm. and 20X with f/1 of 8 mm.—*Edmund Scientific Corp., Barrington 3, N. J.*

For more information circle **237** on inquiry card.

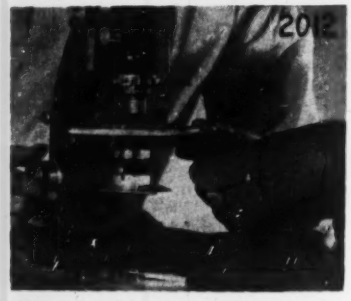
Metallograph

Newly designed "Reichert Metallograph" is said to have "components enabling the most up to date methods for examining metallic surfaces." Added features are: phase contrast for metallurgy, interference tester for surface finish, micro hardness tester, zirconium arc illumination, vibration isolator, and desk with built-in controls.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

For more information circle **238** on inquiry card.

Polarizing Microscope

New polarizing microscope, designed especially for petrography, mining, and industrial use, features ball-bearing low-position fine-focusing stand previously available only with maker's "Dynoptic" instruments. Shown is "Micro-Lite" illuminator; also available is "Opti-Lume" integral substage illuminator.—*Bausch & Lomb Optical Co., Rochester 2, N. Y.*



For more information circle **239** on inquiry card.

Microscope Illuminator

New "Unilux Universal Illuminator" (Austrian-made) is easily installed beneath stage and becomes part of microscope. Features include double lens collector and field iris diaphragm; built-in centerable mirror; supplementary lens on sliding mount; pre-centered low-voltage light source.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

For more information circle **240** on inquiry card.

PHOTOGRAPHY, ETC.

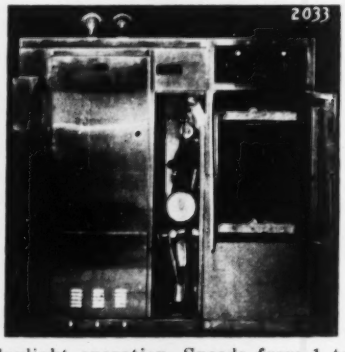
Fast-processing Camera

New "Rapromatic 3000" camera photographs, develops, and projects a picture continuously and automatically within seconds. Portable 14 x 14 x 22-in. case houses camera, processor, and projector; holds up to 200 ft. of 35-mm. film (2500 single frames). Exposed frames are immediately developed and projected on viewing screen. Depending on type of film used, time lag is as little as 2 sec. Any single image can be held on screen for an indefinite period. Thus, in study of transient voltages on a cathode-ray tube, or high-speed motion studies, detailed measurements can be made at any instant. "Rapromatic 3000" accepts a variety of film emulsions, including those sensitive to ultraviolet or infrared; will act as an optical amplifier by increasing screen brightness; provides immediate view and control of phenomena ordinarily invisible or difficult to see; may double usefulness of instruments such as ultraviolet microscope, oscilloscope or stroboscope.—*Kenyon Instrument Co., Inc., 1345 New York Ave., Huntington Station, L. I., N. Y.*

For more information circle **241** on inquiry card.

Film Processing Machine

New "Multi-purpose Film Processor," for 70-mm., 35-mm. and 16-mm. film of any length, is designed for daylight operation. Speeds from 1 to 50 fpm.; adjustable automatic temperature control.—*Oscar Fisher Co., Inc., 1000 N. Division St., Peekskill, N. Y.*



For more information circle **242** on inquiry card.

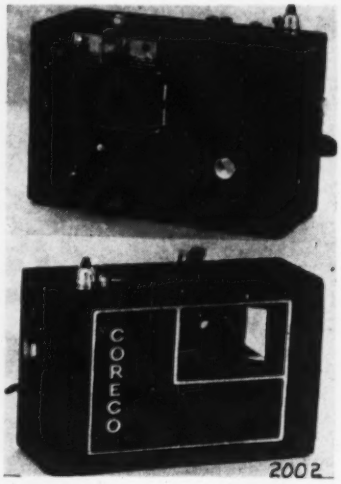
High-speed M-p. Films

New outlet is announced for two Du Pont motion picture films, perforated for high-speed use: they are to be offered through undersigned company. Films involved are Du Pont "Superior 3, Type 927," and "High Speed Rapid Reversal, Type 931." Undersigned will sell them under its "Fastax" label.—*Wollensak Optical Co., 880 Hudson Ave., Rochester 5, N. Y.*

For more information circle **243** on inquiry card.

Clinical Camera

New "Coreco Flash Camera" is completely pre-adjusted; takes black-and-white or color photographs of many inaccessible body areas. To use, insert flash bulb, point at subject and push button.—*American Hospital Supply Corp., 2020 Ridge Ave., Evanston, Ill.*



For more information circle **244** on inquiry card.

LABORATORY

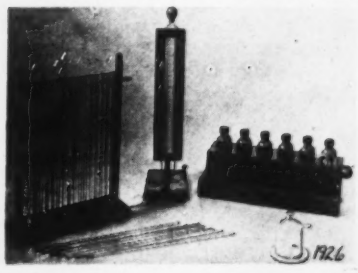
Electrophoresis Apparatus

New "EC 305" electrophoresis apparatus, with stabilized electrolytes, analyzes 12 samples simultaneously under identical conditions of temperature and ionic strength; determines mobilities at three pH's simultaneously; purifies quantities from 0.1 microgram to 100 milligrams; preserves labile compounds by accurate temperature control; employs either paper strip or starch column.—*E-C Apparatus Co., 23 Haven Ave., New York 32, N. Y.*

For more information circle **245** on inquiry card.

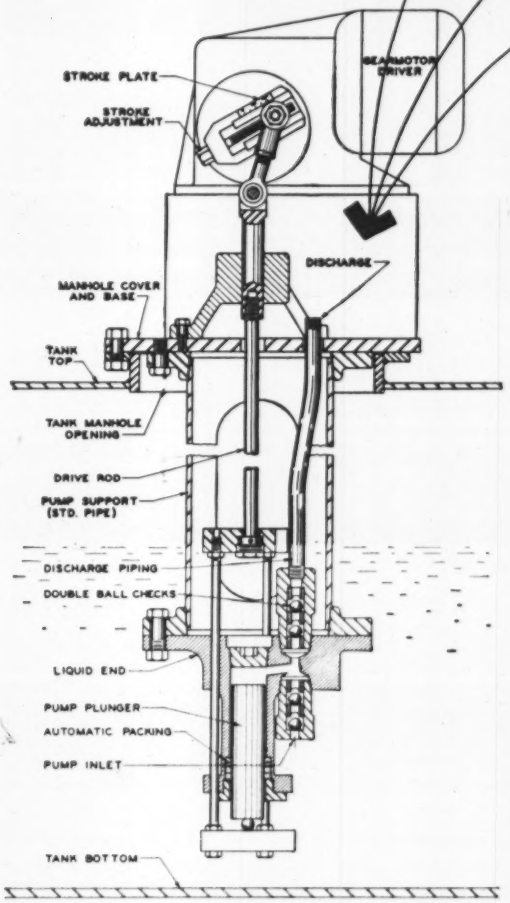
Density-gradient Set

New density gradient analysis set makes it possible to establish with extreme sensitivity the identity or non-identity of origin between two objects or materials. It provides for comparative analysis of glasses, soils,



CONTROLLED VOLUME PUMPS ARE FLOW-CONTROL INSTRUMENTS

- no leakage to atmosphere
- no diaphragm
- no contamination



MERSEMETRIC®...

the new controlled volume pump for submerged operation

Here's a new member of the family of Milton Roy Controlled Volume Pumps. The Mersemetric pumps by direct volumetric plunger displacement, using the exclusive double ball-check on both suction and discharge. Simple and compact, this new pump eliminates the need for a diaphragm. As a result, there can be no fluid contamination. Since Mersemetric is submerged in the fluid being pumped, there can be no leakage to atmosphere.

TYPES *Capsulated or drop-in-tank*

CAPACITIES *3 milliliters per hour to 400 gallons per hour*

MAXIMUM PRESSURE *To1000 pounds per square inch (psi)*

MATERIALS *Full alloy selection*

DRIVE *Air or electric motor*

CAPACITY REGULATION *Manual or automatic and fully adjustable while in operation*

USE *As single units in integrated pumping systems or as final control elements in process instrumentation*

For complete details, write today, for Bulletin 1153-B.

The MERSEMETRIC® Controlled Volume Pump is designed to *eliminate leakage* of corrosive or expensive liquids *by being submersed in the liquid* being pumped. One of its specific applications is pumping concentrated sulphuric acid directly from the main storage tank to point of application, eliminating intermediate tankage or handling by personnel.

MILTON Roy COMPANY

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

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CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

*Patent Applied For

For more information circle **42** on inquiry card.

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POWER Resistors

Carefully crafted for matchless performance, Dalohm miniature power resistors are made to survive the most severe environmental, shock, and vibration conditions.

Also Available RH-250—250 Watts
RS Types—2, 5, and 10 Watt

Dalohm RH type resistors are completely welded from terminal to terminal. They are silicone sealed in a die-cast, black anodized radiator finned housing and mount on subpanel for maximum heat dissipation.

- Temperature coefficient 0.00002/Deg. C
- Ranges from 0.1 Ohms to 55,000 Ohms, depending on type
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%, 5%
- Manufactured in accordance to JAN-R-26A Specifications, Characteristic G

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Columbus, Nebraska
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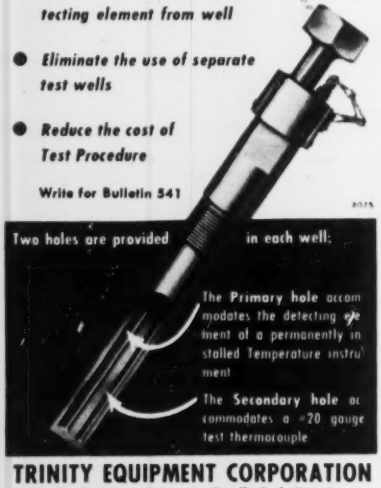
For more information circle **43** on inquiry card.

TRINITY

DOUBLE-BORE THERMOWELLS

- *Minimize the factors of error in Temperature Instrument Test Procedures*
- *Permit accurate test without removing detecting element from well*
- *Eliminate the use of separate test wells*
- *Reduce the cost of Test Procedure*

Write for Bulletin 541


Two holes are provided in each well:
The Primary hole accommodates the detecting element of a permanently installed Temperature instrument
The Secondary hole accommodates a #20 gauge test thermocouple

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494 Westfield Ave., East • Roselle Park, New Jersey
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For more information circle **44** on inquiry card.

CONFIDENTIAL MAP FILE

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For more information circle **45** on inquiry card.

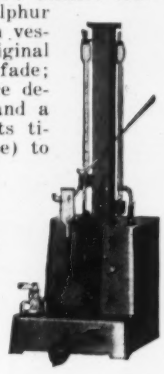
NEW INSTRUMENTS

hairs, mineral materials, etc. Requires 25 mg. or less of sample. Comprises eleven density gradient liquids and bottles, bottle rack, glass tubes and stand, densitometer, combination delivery and suction head.—*Microchemical Specialties Co., 1834 University Ave., Berkeley 3, Calif.*

For more information circle **246** on inquiry card.

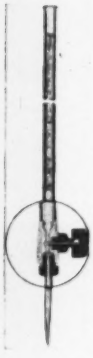
Automatic Sulphur Titrator

New "Leco Automatic Sulfur Titrator" for iron and steel analyses by combustion method utilizes iodometric method. As sulphur gases reach titration vessel, solution's original blue color begins to fade; a photoelectric device detects color change and a solenoid valve admits titre (potassium iodate) to restore original blue intensity. All burettes are automatic-leveling. Iodate burette is Shellbach type making meniscus appear as sharp double inverted "V."—*Laboratory Equipment Corp., St. Joseph, Mich.*



For more information circle **247** on inquiry card.

Needle-valve Burette



New "Needle Valve Buret" is designed to perform titrations without annoyance of stopcock adjustments. A technician can work faster, more accurately, and eliminate stopcock grease contamination. Liquid comes in contact with only glass and Teflon. Other plastic parts, not in contact with liquid, are made of Hysol (resistant to acid, alkalis, salt, and nearly all organic liquids). Precision-bore Pyrex tube is calibrated to Bureau of Standard tolerances; fused-in ceramic scale insures permanent linearity.—*Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y.*

For more information circle **248** on inquiry card.

Recording Densitometer

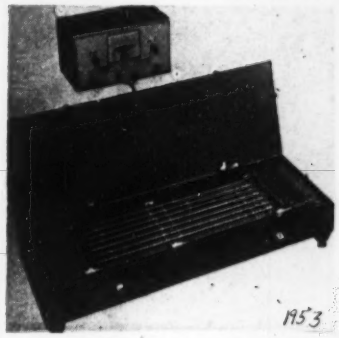
New "Densigraph," manually-operated recorder for rapid photometric analysis of light-absorbing materials on dry paper strips as obtained in electrophoresis and chromatography, determines light transmission and lineal separation of stained areas on

strips, and simultaneously combines usual operations of scanning, indicating and recording to provide a continuous ink record of percentage light transmission. Designed for use in clinical techniques, useful also with other materials having electromigratory characteristics.—*Arthur H. Thomas Co., 230 S. 7th St., Philadelphia 5, Pa.*

For more information circle **249** on inquiry card.

Ionograph

New "Junior Ionograph," for electrophoresis on wet filter paper, separates and identifies mixtures of biological materials such as amino acids and proteins; is useful in analyses of

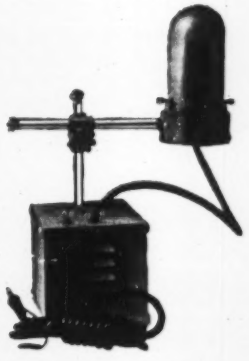


pharmaceutical products, etc.; is a modification of "Precision Ionograph" announced two years ago. It accommodates seven filter paper strips or a single sheet for two-dimensional electromigrations.—*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

For more information circle **250** on inquiry card.

Potassium Laboratory Arc

New Potassium Laboratory Arc furnishes monochromatic radiation of potassium with approx. 97 percent of



energy radiated in region of 7699 to 7765 A.u.; other line radiations easily removed by filtering. Two complete units: a lamp housing and an enclosed electrical auxiliary. No special precaution; no adjustments; lamp can be burned in any position.—*George W. Gates & Co., Inc., Hempstead Turnpike & Lucille Ave., Franklin Square, L. I., N. Y.*

For more information circle **251** on inquiry card.

Laboratory Balance

New "Special Purpose" model of "Gram-atic" balance has same capacity (200 grams), accuracy (0.05 mg.),

Circle **46** on inquiry card ⟶

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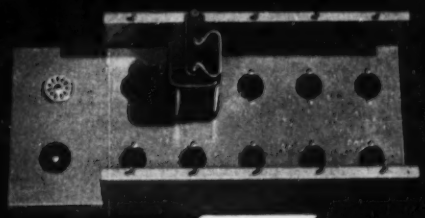

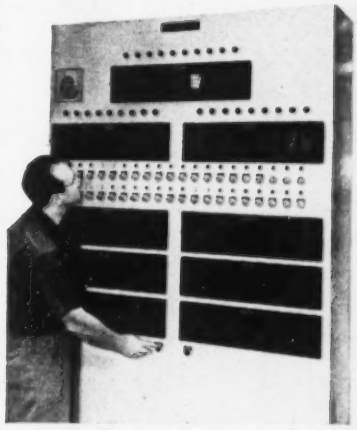

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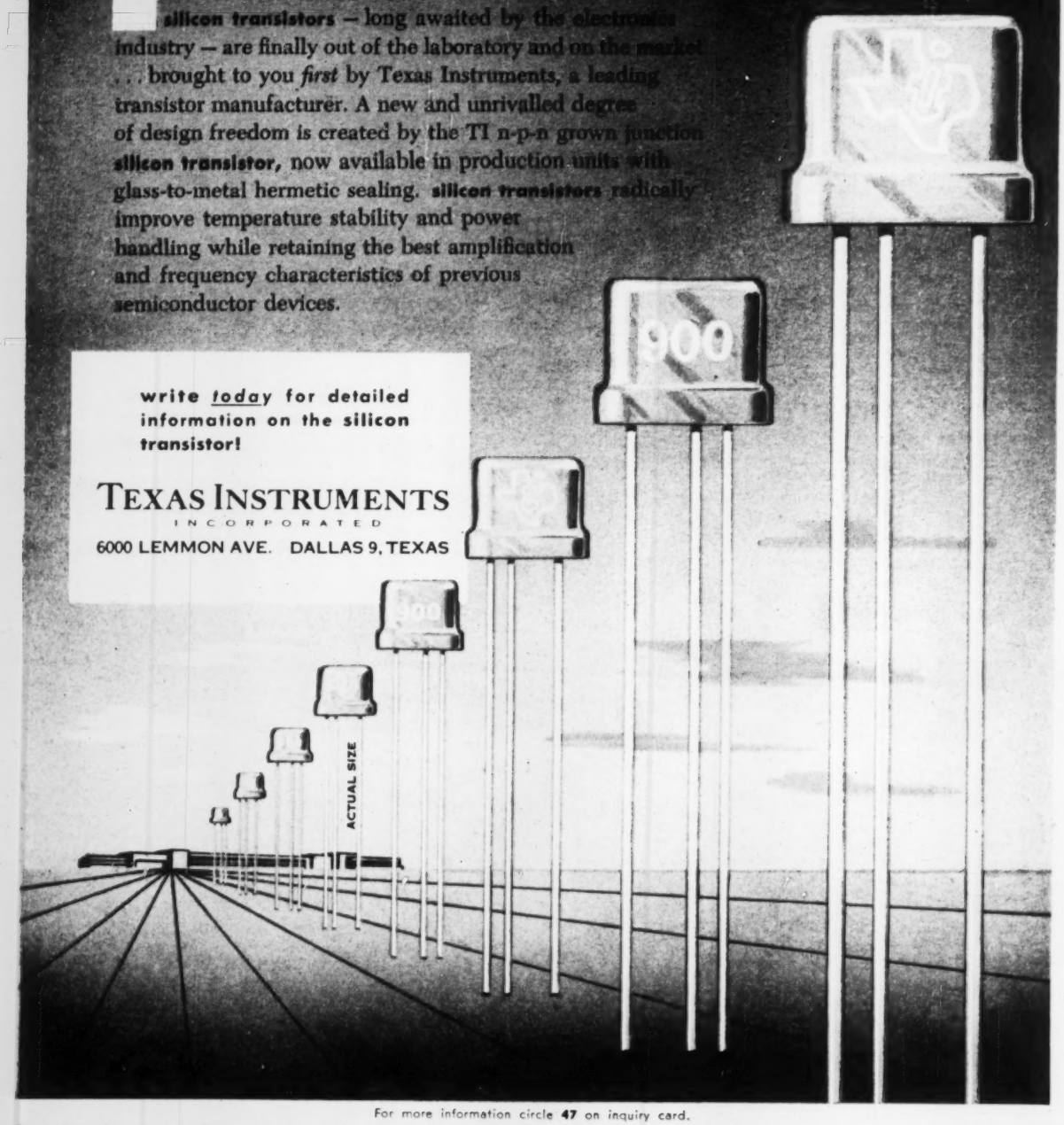
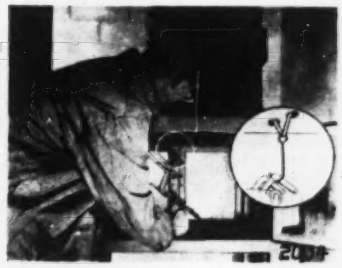


For more information circle **47** on inquiry card.



optical range (100 mg.) and high-speed semi-automatic controls as standard "Gram-atic." Modifications include: two ports in floor beneath pan to admit special yoke; hook for holding sample; compensating weight to balance out weight of yoke when balance is used in the conventional manner. Cover caps for ports are included to permit use of balance in usual weighing roles.—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

For more information circle **252** on inquiry card.

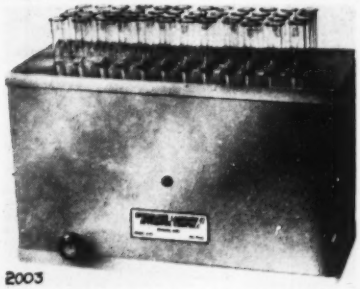
Magnetic Stirrer

New "Forma-Jumbo-Mag" stirs magnetically in closed vessels or in any shaped flask; ample power for stirring large volumes and high-viscosity liquids. Two speed controls: coarse and fine adjustment. Variable-speed 1/20-hp. motor gives constant stirring at selected speed. Pilot light signals current on or off. Stirrer equipped with dove-tail muffs. Assembly mounted on large rubber feet.—*Forma-Scientific, Inc., Box 332, Marietta, Ohio.*

For more information circle **253** on inquiry card.

Tube Heater

New "Slaco Tube Heater" is an electric unit said to combine advantages of flame, water bath, oil bath



and sand bath methods; maintains desired temperature between 25 and 300 C. to 0.01 deg. Four models: 75 holes for test tubes to 13mm. OD; 48 holes for tubes to 19mm.; 33 holes for Blood Sugar tubes; 17 holes for NPN and 50-cc. centrifuge tubes.—*American Hospital Supply Corp., 2020 Ridge Ave., Evanston, Ill.*

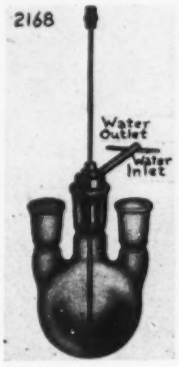
For more information circle **254** on inquiry card.

Reflecting Polariscopes

New reflecting polariscopes are for detection of strain—tension, compression, or fracture — in any transparent or translucent material. Operation: object is placed on top ground glass surface and any existing strains are immediately reflected in sharp color in mirror: tension in red, compression in blue, fracture as a blue-green line along crack. Two sizes: 2-ft. bench model for lab and 5-ft. production model for inspection and assembly.—*R. Fuess, Inc., 39 W. 60th St., New York 23, N. Y.*

For more information circle **255** on inquiry card.

Laboratory Stirrer

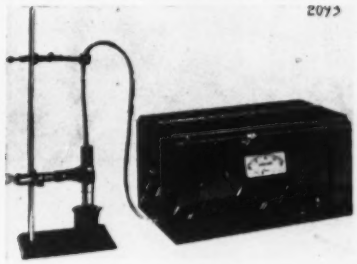


New "Stir-O-Vac" stirs under vacuum without mercury seals; operates at speeds up to 20,000 rpm. and vacuum down to 2 mm.; is made of stainless steel; features "cruciform" impeller; has built-in cooling jacket surrounding oilless bearing; can be driven by air motors or electric motors.—*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle **256** on inquiry card.

Ultrasonic Viscosimeter

New ultrasonic viscosimeter which features a rugged sensitive probe without moving parts is said to provide instantaneous, accurate and continuous measurement of solution vis-



cosities from zero to 100,000 centipoises or higher at room or elevated temperatures; will operate under heavy pressures. Three models: one for laboratory; two for industrial applications (may be used in their own steel cabinets or mounted on a stand ard relay rack); third type explosion and water-proof. Provisions are in-

The Model TC-2 Temperature Test Chamber is a portable, self-contained, easy-to-operate unit ideal for laboratory and production line use.
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Temperature Range: −65° F to +350° F.
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MODEL TC-2
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PORTABLE TEMPERATURE TEST CHAMBER

For more information circle **48** on inquiry card.

cluded for connecting to any standard recorder-controller for continuous monitoring of processes.—*Ultrasonic Engineering Co., Box 46, Maywood, Illinois.*

For more information circle **257** on inquiry card.

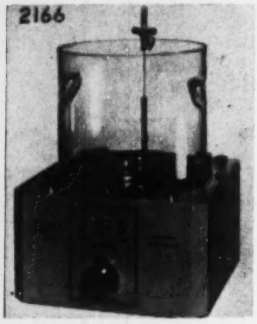
Water Purifier

New "Quikpure No. 12837" changes ordinary tap water into chemical equivalent of triple-distilled water (in terms of specific resistance) for as little as ten cents a gallon. It is a 16-oz. polyethylene squeeze bottle, bottom of which contains a mixture of cation and anion exchange resins. Tap water poured into bottle comes into immediate contact with resins and is converted to distilled water in about one minute. Cap permits user to discharge distilled water from squeeze bottle but will not allow resins to escape: they remain in bottle and may be used repeatedly up to about 25 gal. of water, (depending on its hardness). When resins cease to react, a color change occurs. "Quikpure" is said to provide greater control over water produced than former methods which utilized a cartridge filter. User can regulate the time of contact. Higher than triple-distilled water is obtained by longer than one minute contact with "Quikpure."—*Central Scientific Co., 1700 W. Irving Park Rd., Chicago, Ill.*

For more information circle **258** on inquiry card.

Thermostated Bath

New "Model 12A Universal Infrared Bath" holds any temperature from 2 C. to 65 C. within 0.005 C.; has con-

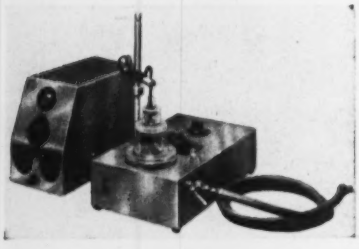


nections for externally circulating the temperature-controlled water.—*Kinetic Instrument Co., Highland Park, Illinois.*

For more information circle **259** on inquiry card.

Freezing-point Depression Apparatus

New freezing-point depression apparatus permits rapid cryoscopic os-

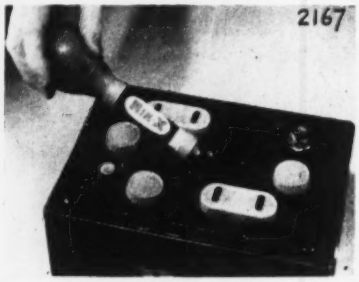


motic-activity determinations of 1-cc. samples of aqueous solutions. Accuracy of method is better than plus-minus 2 percent or 1 milliosmole per liter, whichever is greater, over range of 0 to 1.85 osmolal concentrations.—*American Instrument Co., Inc., Silver Spring, Maryland.*

For more information circle **260** on inquiry card.

Water Purifier

New "Min-X" is a double-acting demineralizer using resin filters for production of equivalent of triple-distilled water. Double action is said to

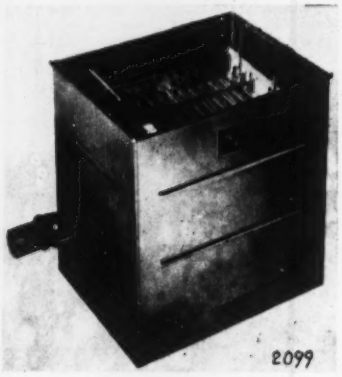


increase efficiency of filtering operation 50 percent over other type units. To use: allow bulb to fill with water, then squeeze contents into appliance or container; insert refill when contents of original tube turn brown color.—*LaMotte Chemical Products Co., Towson 4, Baltimore, Md.*

For more information circle **261** on inquiry card.

Test-tube Washer

New "Amherst Test Tube Washer" frees technicians from drudgery; utilizes syphon principle; rinse-washes



test tubes continuously and automatically. Basket is adjustable to accommodate tubes from 75 to 150 mm. long.—*Will Corp., Rochester 3, N. Y.*

For more information circle **262** on inquiry card.

DIMENSIONAL

Dial Gage

New "JKA Universal Dial Comparator," for quickly measuring dimensions of small parts, combines a dial and pincer type jaws to permit gagings not otherwise possible with conventional measuring equipment. Simple release permits easy introduction of test pieces. It is said that "JKA" can save from 35 to 85 percent of small parts inspection time; ob-

viates need for expensive small parts checking fixtures and snap gages. Range 0-10 mm., graduation 0.01 mm.; range 7/16 in., graduation 0.0005 in.—*Mercury Supply Co., 410 Fairview, Elmhurst, Illinois.*

For more information circle **263** on inquiry card.

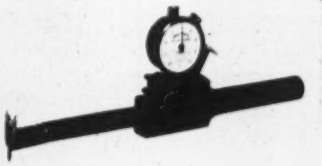
Dividing Machine

New "Model Z-950" imported dividing machine permits graduation of circular surfaces up to 950 mm. diam. and cylinders to 1400 mm. diam. Linear graduations to 800 mm. in length can be performed by mounting a separate head upon machine.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

For more information circle **264** on inquiry card.

Snap Ring Groove Gages

New dial indicator gages enable user to inspect internal snap ring grooves from 0.240 to 5.270 in. diam.;



can also be used for checking out-of-round, inside diameters, deep holes, recesses, taper, inside spherical radii. New gages are self-centering; diameters are measured directly. Dial indicator graduated to 0.0001 in.—*Reliant Industries, 4947 Firestone Blvd., South Gate, Calif.*

For more information circle **265** on inquiry card.

Dial Indicators for Snap Gages

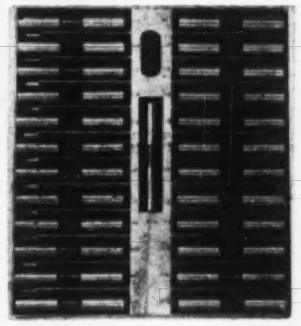
New line of "Dializers" converting standard (AGD) adjustable-limit snap-gage frames to dial snap gages

are available (in addition to others) having either a 1¾-in. or a 2¼-in. diam. indicator; also a wider choice of graduation values.—*Standard Gage Co. Inc., Poughkeepsie, N. Y.*

For more information circle **266** on inquiry card.

"Tenth" Plug Gages

New "Tenth Plug Gauges" are sets of 25 plug gages, available in fractional nominal sizes from ⅛-in. to



1-in. in increments of 1/64 in. Each set comprises one gage of nominal size, plus twelve gages of increasingly larger sizes in 0.0001-in. increments, and twelve gages in 0.0001-in. decrements. They may be used as work gages as well as for inspection. Hardness is Rockwell C62/C64.—*Deltronic Corp., 9010 Bellanca Ave., Los Angeles 45, Calif.*

For more information circle **267** on inquiry card.

Automatic Gear Selector

New automatic gear selector segregates 100 percent of spur or helical gears produced into (1) satisfactory,

(2) oversize, (3) undersize. It can be coupled to any gear tooth cutting or finishing machine. Machine operator feeds gears into selector, or gears can be inspected in an automatic setup without operator attention. Selector can be furnished with an automatic shut-off, coupled with a counter, to stop production machine if any pre-set number of consecutive gears are rejected, or if percentage of rejects exceeds pre-set limits.—*Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.*

For more information circle **268** on inquiry card.

Beta-type Thickness Gage

New "Model RBM AccuRay" beta gage, for continuously measuring thickness of coatings on base materials or thickness of sheets passing over a roll from one side of sheet, is a non-contacting reflection-principle gage comprising: source of radiation, radiation detector, and recording console. Operation is based on reflection of a certain percentage of high-speed electrons (from source above base material) back into detector unit. When a coating is applied to base material, amount of reflected radiation depends on coating thickness. Amount is measured and expressed in "AccuRay Re-

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For more information circle **49** on inquiry card.

corder" in terms of weight per unit area or thickness. Source and reflection-meter are enclosed in a housing which traverses width of sheet on twin steel support tubes capable of spanning sheets up to 160 in. wide. New unit features an automatic standardization cycle which periodically compensates for changing ambient conditions, circuit variations, and source decay. Additional equipment: continuous scanning mechanism, weld protection unit, and summation computer for totaling combined weights when gages measure coatings on both sides of sheet.—*Industrial Nucleonics Corp.*, 1205 *Chesapeake Ave., Columbus, Ohio.*

For more information circle **269** on inquiry card.

Optical Comparator

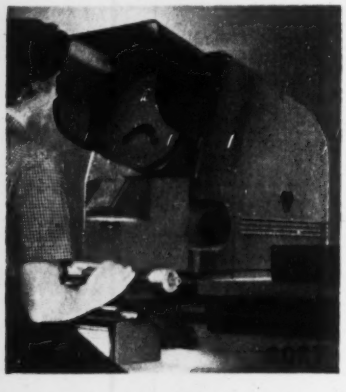
New "Model R-300" advanced-design optical comparator features maker's "Multi-Phase" optical system said to project an upright properly-oriented image with exceptional defi-

nition and screen brightness and to offer advantages of long focal lengths at every magnification, thereby providing exceptionally large working-space clearance between lenses and platform. Instant change from one magnification to another.—*Portman Instrument Company, Inc., Town Dock Rd., New Rochelle, N. Y.*

For more information circle **270** on inquiry card.

Optical Comparator

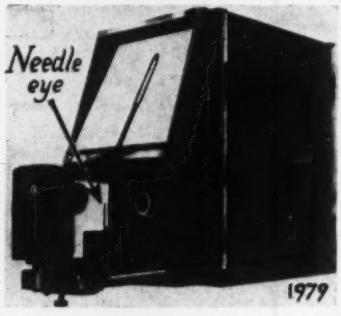
New optical bench comparator with one-knob focusing and understage illumination is designed for fast comparison of precision parts against master charts, in large-volume quality-control operations or short-run inspections, by relatively unskilled personnel. Wide-angle screen permits viewing by several people at once. Magnifications of 10, 20, 25, 31¼, and 50; lenses quickly interchanged. Addition of micrometer drums graduated to 0.0001 in. permits projector to be used as a measuring instrument.—Made by Bausch & Lomb Optical Co., Rochester, N. Y.; distributed by *The DoAll Co., DesPlaines, Illinois.*



For more information circle **271** on inquiry card.

Optical Comparator

New moderate-cost optical comparator is said to be designed specifically

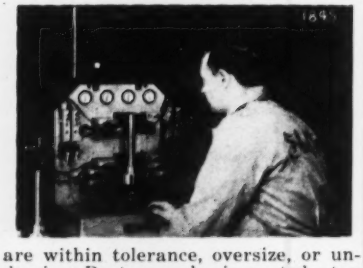


for mass production; has 10-in. square fine-grain frosted glass screen; choice of magnifications.—*Tecna Products Co., 15 Whitehall St., New York 4, N. Y.*

For more information circle **272** on inquiry card.

Automatic Gage

New "Multichek" gage indicates by means of colored electric lights whether or not thirteen dimensions



are within tolerance, oversize, or undersize. Parts can be inspected at a rate of 600 to 800 per hour.—*The Sheffield Corp., Dayton 1, Ohio.*

For more information circle **273** on inquiry card.

Internal Thread Gage

New "Internal Thread Comparator" permits fast visual gaging of all forms and classes of internal threads

in diameters ranging from ⅜ in. to 1½ in. Threaded parts can be gaged at inspector's bench or on machine at rate of 20 or more per minute. Indicator tells at a glance whether parts are oversize, undersize, tapered, or if accumulated lead and angle error are within established tolerances.—*Hanson-Whitney Co., 169 Bartholemew Ave., Hartford, Conn.*

For more information circle **274** on inquiry card.

Six-dimension Gage

New bench-type air gage automatically checks six critical dimensions on engine pistons. Chrome-plated air ring incorporates two sets of matched "Plunjet" gaging cartridges for checking skirt diameter at top and bottom, including 0.001 taper, two air spindles each having six air jets for determining average diameter of each pin bore, and two airsnaps for measuring height between centerline of pin bores and top of dome. Pin bore diameters are classified five sizes in increments 0.0001 in. and skirt diameters are segregated into 16 classifications of 0.0002 in. each. Gage requires no special skills: operator places piston in air ring, and float positions in "Precisionaire" column tell whether or not dimensions are in tolerance and their classifications.—*The Sheffield Corp., Dayton 1, Ohio.*

For more information circle **275** on inquiry card.

TESTING

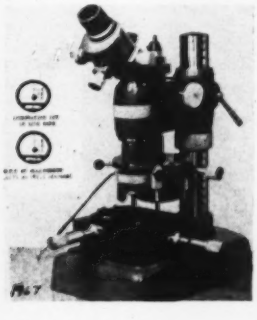
Grease Tester

New "Automatic Grease Robo-Worker" motor-driven grease working machine, suitable for ASTM D 217, AN-G-15A, and other tests, is mounted on a heavy structural base, includes a preset counter for presetting working operations up to 99,999 strokes; can be used for working other materials where continuous operation affects consistency or penetration.—*Labline, Inc., 217 N. DesPlaines St., Chicago 6, Ill.*

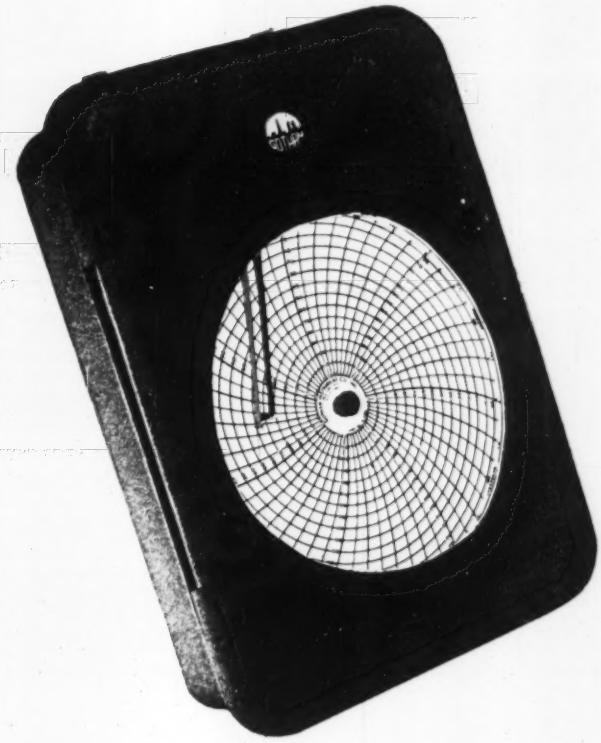
For more information circle **276** on inquiry card.

Microhardness Tester

New tester for hardness of small finished steel parts, electroplating deposits, foils, etc., is a portable bench



CHECK THESE 3 WAYS YOU CAN SAVE WITH THIS MULTI-PURPOSE INSTRUMENT



Here is the most sensible idea you've ever seen in a recorder or controller—an instrument you can change as your instrument needs change, that you can add to, subtract from, or whose functions you can increase or decrease at little or no expense.

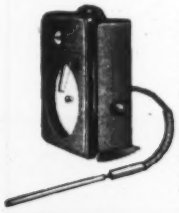
✓ **Save money when you add new functions by adding only those new assemblies needed.**

✓ **Save time-delays by making changes on the job site without returning to factory.**

✓ **Save money on inventory. Parts are interchangeable, fit all Gotham Convertible recorders. You can service a whole group with a minimum stock of basic elements.**

What you can do with the Gotham Convertible

Depending on the chart size of the recorder (6", 9" or 12") you can have a 1-2-3 or 4 pen recorder with 14 pressure, temperature and time operation combinations or a recorder-controller with 38 possible pressure, temperature, and time combinations.

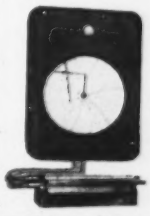


SELF-CONTAINED PORTABLE RECORDER

A portable recorder which has a carrying handle, legs and retaining holder for capillary and bulb. Built from Gotham standard elements, interchangeable with other Gotham instruments. 6", 9" and 12" chart sizes. Mercury, Vapor or Pressure Activated. Spring or electric chart drive. See Catalog 400.

RECORDING PSYCHROMETER

Incorporates the same highly accurate and responsive thermal systems and contains all other Gotham standard convertible features. Wet and dry bulb type. Motor-driven suction fan. 12" chart size. Catalog 400.



RECORDING HYGROMETER

A 2-pen recorder of the wet and dry bulb type. Mercury or Vapor Actuated. 9" and 12" chart sizes. Available with variety of wet and dry bulb assemblies depending on application. Catalog 400.

GOTHAM INSTRUMENTS

Keep everything under control with Gotham

GOTHAM INSTRUMENTS
Division of American Machine and Metals, Inc.
Dept. 2, 233 Broadway
New York 12, New York

Please send me a copy of your

- ☐ Catalog 100—Industrial Thermometers
- ☐ Catalog 200—Dial Type Thermometers
- ☐ Catalog 400—Recorders, Psychrometers, Hygrometers
- ☐ Catalog 500—Controllers
- ☐ Have your representative call. No obligation.

Name _____ Title _____

Company _____

Address _____

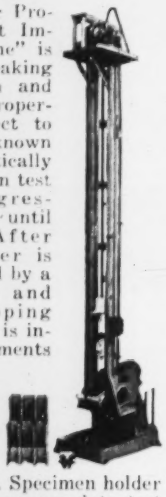
City _____ Zone ____ State _____

For more information circle **50** on inquiry card.

type instrument combining a diamond penetrator with a 400-power microscope which reads hardness by measuring impression to 0.0005 mm. (half a micron). Instructions and tables are furnished to convert readings into Rockwell and other standard hardness scales.—*George Scherr Co., Inc., New York* 12, *N. Y.*

For more information circle **277** on inquiry card.

Automatic Impact Tester

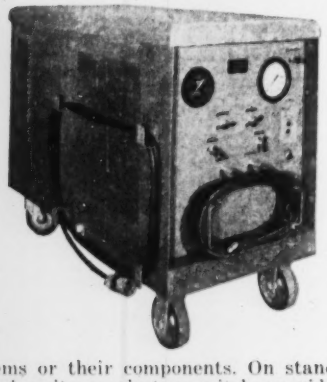


New "Automatic Progressive and Repeat Impact Testing Machine" is for determining breaking point of gear teeth and studying dynamic properties of parts subject to shock. A hammer of known weight is automatically raised and dropped on test specimen from progressively higher points until specimen breaks. After each stroke, hammer is picked up on rebound by a motor-driven chain and raised to next dropping point. Height of fall is increased by 1-in. increments for each succeeding stroke. Tester can also be set to deliver impact repeatedly from any desired height between 6 in. and 10 ft. Specimen holder can be adjusted to accommodate test materials up to 24 in. high. T-slots in bed-plate facilitate positioning specimens.—*Tinius Olsen Testing Machine Co., 1116 Easton Rd., Willow Grove, Pa.*

For more information circle **278** on inquiry card.

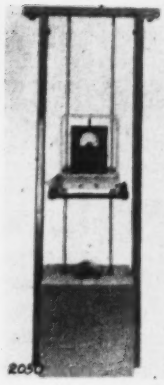
Pneumatic Test Stand

New portable high-pressure pneumatic test stand has air at pressures up to 3500 psi. supplied by a 16- to 26-scfm. three-stage compressor for testing complete high-pressure systems or their components. On standard unit, a selector switch provides air at any two desired pressures accurate to 2 percent. If dry air is required, unit is provided with a dehumidifier which can lower dewpoint of intake air from 100 F. to minus 67 F. Drives: electric motor (220 volts, 3 phase, 60 cps.) or four-cylinder gasoline engine. Unit can be supplied mounted on a Jeep.—*Kahn & Co., Inc., 541 Windsor St., Hartford, Conn.*



For more information circle **279** on inquiry card.

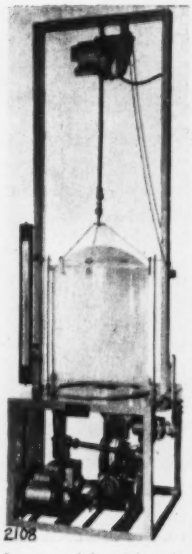
Shock Durability Tester



New "Jolta" guillotine - type shock tester for instruments and components accommodates devices up to 4 lbs. and up to 5 x 5 x 5 in. Devices can be tested while in operation and under electrical load. Computation charts are supplied for interpretation of tests by personnel with no special training. Tester meets requirements of JAN-S-44 and MIL-STD-202, "Method 202."—*Jan Hardware Mfg. Co., Inc., 75 N. 11th St., Brooklyn* 11, *N. Y.*

For more information circle **280** on inquiry card.

Vacuum Chamber

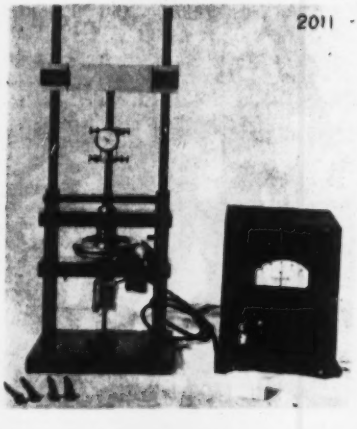


New type of vacuum chamber makes it possible to observe at all times complete unit being tested. Jar encloses a working space 24 in. high and 24 in. diam.; cannot be raised unless controls are in "dive" position. Power hoist facilities raising and lowering. Altitudes up to 100,000 ft.; simulated rate of climb of 32,000 ft. per minute up to 60,000 ft. Standard equipment includes safety devices, manometer, etc.—*American Research Corp., 11 Brook St., Bristol, Conn.*

For more information circle **281** on inquiry card.

Extensometer Comparator

New portable comparator is for calibrating extensometers, compressometers, dial gages, and similar instruments (primarily those defined in ASTM E83-52T as Class B instruments). Elimination of mechanical linkages is accomplished by use of a "Microformer" (miniature variable transformer) and null balance indicator to apply small displacements to extensometers with an accuracy better than 10 microinches for calibration.—*Baldwin-Lima-Hamilton Corp., Philadelphia* 42, *Pa.*



For more information circle **282** on inquiry card.

Sand and Dust Machine

New "Sand and Dust Test Machine" meets government specifications; features compact design using propeller type vane axial fans; eliminates settling of sand and dust at low velocity; separate high-velocity low-volume air system; ductwork designed for minimum pressure drop. Recording and control of temperature, relative humidity and sand and dust density available.—*International Radiant Corp., 40 Matinecock Ave., Port Washington, L. I., N. Y.*

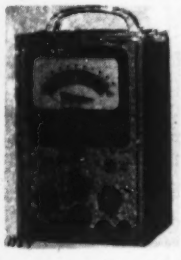
For more information circle **283** on inquiry card.

Salt Spray Test Cabinet

New "Singleton H-T Sincolite Salt Spray Test Cabinet" is completely transparent; is said to yield test results "within 10 percent of absolute duplication; is said to meet ASTM B-117-49T and intent of Government specs for similar equipment; is the only one of its kind made of "H-T Sincolite" which is non-porous, inert to test solutions, and prevents secondary galvanic acceleration of corrosion.—*The G. S. Equipment Co., 5317 St. Clair Ave., Cleveland 3, Ohio.*

For more information circle **284** on inquiry card.

TV Component Tester

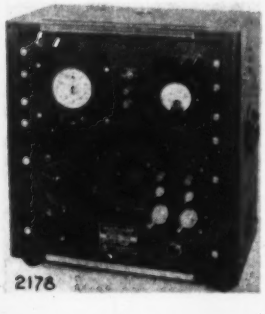


New "TV Component Tester" tests: (1) flyback transformers and yokes; (2) selenium rectifiers; (3) picture tubes. Also reactivates worn-out picture tubes by restoring brightness to them.—*Transvision, Inc., New Rochelle, N. Y.*

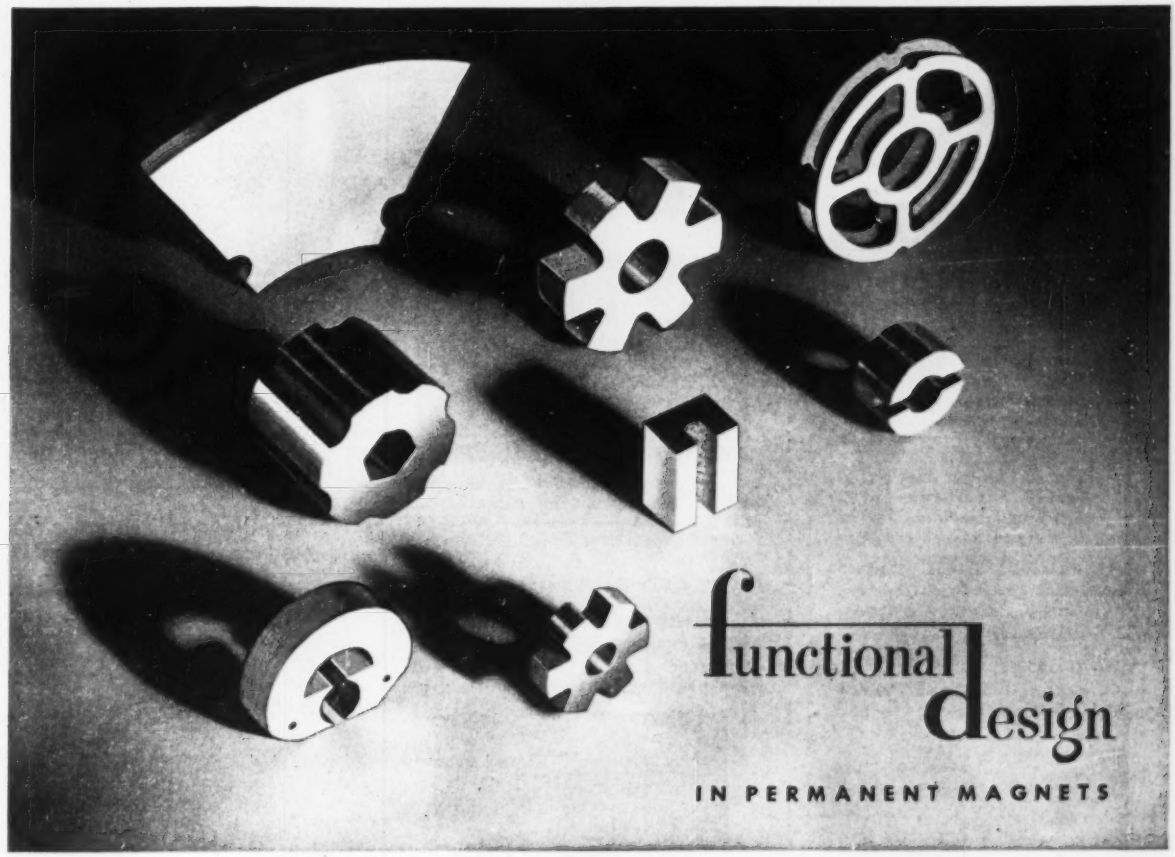
For more information circle **285** on inquiry card.

High-current Test Unit

New "Model 1010-336/336" portable high-current testing instrument has a built in multi-range ammeter and a timer which can be furnished to totalize 60 seconds in 0.01 sec. or 60 minutes in 0.01 min., to measure tripping



ONE IN A SERIES: discussing the importance of selecting the proper permanent magnet to use in your product



Why SOUND, FUNCTIONAL MAGNET DESIGN guarantees superior product performance

Magnets must be "tailored" to your product . . . tailored in size, shape, and the material used . . . if greatest efficiency, at the lowest possible cost, is to be expected.

The magnet assemblies shown above are typical of such "tailoring." Those used in test meters, for example, are designed specifically to maintain a magnetic field of uniform high energy, so necessary to the precise operation of such meters.

Others—for holding applications—are designed so that their magnetic circuits provide the greatest possible tractive power. In applications where the magnet acts on moving parts of an assembly, still different designs may be required.

Our engineers—specialists in permanent magnet design and application—welcome the opportunity to assist you with your designs. For their recommendations—without cost or obligation—write us today. Or return the coupon below for a free copy of the helpful article, "Selecting the Proper Permanent Magnet Material for Your Product."

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For more information circle **51** on inquiry card.

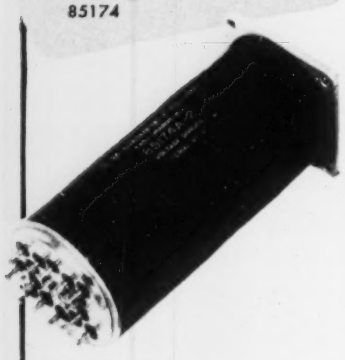
EXTREME STABILITY

GIANNINI

VOLTAGE DIVIDER

Uniform performance—even when exposed to severe temperature changes, corrosive atmosphere and high humidity—makes the Giannini Fixed Voltage Divider ideal in aircraft or varied industrial applications. Freedom from the effects of vibration, shock and acceleration results from the new use of potting compounds and a continuous length of resistance wire.

GIANNINI
Voltage Divider
85174



Available with up to 23 voltage divisions—any spacing—high total resistance values.

Resistance tolerance for each section can be held to ± 0.5%.

Temperature coefficient of the wire may be matched—or as low as ±.00002 ohms/ohm/°C.

Length: 4-11/32"
Diameter: 1-3/4"
Mounting Flange: 1-13/16" square

•

We'd be pleased to furnish more complete information — or assist you in a special problem.

Giannini

G. M. GIANNINI & CO., INC.
ElectroMechanical Division
East Orange • New Jersey

For more information circle **52** on inquiry card.

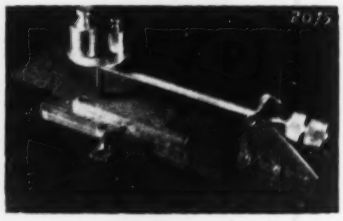
NEW INSTRUMENTS

time of motor overload relays, circuit breakers, fuse links, etc., while operated under overload conditions.—*Multi-Amp Corp., 10 Third St., Newark, N. J.*

For more information circle **286** on inquiry card.

Adhesion and Scratch Tester

New Adhesion and Scratch Tester meets demand of paint industry for a simple and accurate method of test-

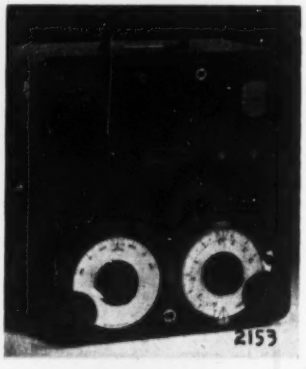


ing, on a comparative basis, the scratch resistance and adhesion of paint to metal surfaces.—*Princeton Paint Laboratories, Inc., P. O. Box 384, Princeton, N. J.*

For more information circle **287** on inquiry card.

Comparison Bridge

New "Type 1604-B" combines accuracy of a laboratory bridge with speed required for production testing;



includes a 400-cps. test frequency in addition to 1000 and 5000 cps. of preceding models. Feature is adaptability to either direct measurement or high-speed sorting. Automatic sorting equipment can be operated. Bridge checks components having impedances between 2 ohms and 20 megohms, with a basic accuracy of 0.1 percent. Two impedance-deviation ranges: ±5 percent and ±20 percent.—*General Radio Co., Cambridge 39, Mass.*

For more information circle **288** on inquiry card.

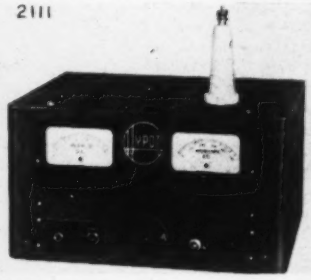
Bronze Screen Rooms

New bronze screen rooms employ same type of portable construction as maker's copper screen rooms; have an attenuation rating of 126-128 db. Inner and outer shields are physically and electrically isolated, being connected only at power entrance. Spacing of 1-⅝ in. between screens. Standard sizes 8 ft. high, 5 or 10 ft. wide, various lengths from 65 in. to 42 ft.—*Erik A. Lindgren & Associates, 4515 Ravenswood Ave., Chicago 40, Ill.*

For more information circle **289** on inquiry card.

High-voltage D-c. Tester

New "Portable Model 421 D.C. Hypot," rated 0-10,000 v.dc. at 0-500 microamps., provides continuously



variable output voltage and current; has 4½-in. kilovoltmeter and microammeter, and panel-mounted excessive-leakage-current neon indicator. Input is 115 v.ac.—*Associated Research, Inc., 3767 W. Belmont Ave., Chicago, Ill.*

For more information circle **290** on inquiry card.

Insulation Tester

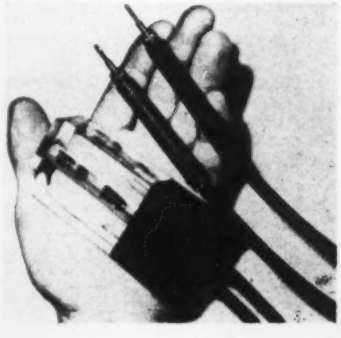
New "Series L Megohm Meter" is designed for high-speed testing of transformer winding, motor windings,

cables, capacitors and all other applications of insulation leakage in accordance with ASTM specification D-257-52T.—*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J.*

For more information circle **291** on inquiry card.

Voltage Tester

New "Model AP 1," for testing circuits from 90 to 600 volts at d-c. to 400-cps. a.c., substitutes an electronic means for a mechanical one. Operating section is transparent: a low voltage lights only bottom part, higher



Do YOU have operations similar to these?

Then check the extra savings possible with industry's great new profit-builder –

Arnold O. Beckman OXYGEN CONTROL!

Where others are cutting costs, boosting profits...

- **Boilers, Direct Fired Heaters or Stills, Rotary Kilns**
  Arnold O. Beckman Oxygen Measurement on Flue gases insures greater savings through optimum combustion efficiency, lower fuel costs.
- **Hydrogenation, Hydrofining, Gas Compressors, Sulfur Grinding**
  Arnold O. Beckman Oxygen Control in explosive atmospheres protects lives, prevents costly damage, reduces fire risks.
- **Air Liquifraction, Production of Acetylene, Butadiene and Similar Gases**
  Arnold O. Beckman Oxygen Measurement insures higher product quality through minimum oxygen or air contamination.
- **Resin Kettles, Color Pigments, Product Storage**
  Arnold O. Beckman Oxygen Measurement of inert purge systems minimizes oxidation, protects product standards.

Send For This Helpful Data–

BULLETIN 103: *Describes the Model G-2 Beckman Oxygen Analyzer — the instrument to use where maximum accuracy is essential. Model G-2 ranges are available for oxygen concentrations as low as 0-1000 parts per million — as high as 95-100% — or virtually any other range or combination of ranges. Bulletin 103 describes the unique magnetic operating principle used in Model G-2 Analyzers, equipment, accessories and typical applications.*

BULLETIN 108: *Describes the Model F-3 Beckman Oxygen Analyzer —the instrument designed primarily for industrial applications such as combustion control, catalyst regeneration, sulfur grinding, etc., which require an oxygen measuring range of 0-5%, 0-10%, 0-15% or higher. Bulletin 108 describes the unique magnetic operating principle used in Model F-3 Analyzers, gives equipment specifications and typical applications for this instrument.*

BULLETIN AD607: *Contains helpful charts and data on most efficient methods of controlling various combustion processes.*

BULLETIN AD610: *Contains helpful data on Chemical Applications, illustrates a typical installation, lists equipment required.*

BULLETIN AD611: *Contains helpful data on Tunnel Kiln Applications, shows typical installation, details equipment required.*

BULLETIN AD613: *Contains helpful data on measuring O_2 content of High Purity Gases, shows typical sampling system, lists equipment required.*

Want more details?

In addition to the applications highlighted above, there are many other processes where Arnold O. Beckman Oxygen Control brings new profits, new savings, new production efficiencies. Write for additional information, outlining your particular field of operation.

Arnold O. Beckman, Inc.

1020 Mission St., South Pasadena 9, California

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☐ 103 ☐ 108 ☐ 607 ☐ 610 ☐ 611 ☐ 613

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CHECK THESE IMPORTANT ADVANTAGES OF ARNOLD O. BECKMAN OXYGEN ANALYZERS

DIRECT MEASUREMENT: Operating principle is based on unique paramagnetic properties of Oxygen. Arnold O. Beckman Oxygen Analyzers measure oxygen by *direct physical* means. No chemicals are required, no saturated atmospheres, no "hot wires" or other complex devices that may alter the composition of the sample gas.

HIGH ACCURACY: Readings are accurate within ±1% of full scale for spans of 2% O_2 and greater (e.g. .02% O_2 on 0-2% O_2 range). Accuracy is unaffected by ambient temperature variations.

LINEAR SCALE: Calibration of Arnold O. Beckman Oxygen Analyzers is strictly linear and the scale is accurate over the entire range.

SIMPLE SAMPLING: Only a small volume is necessary — 50-250 cc. per minute. Accuracy is not affected by variations in flow rate. Samples may be dry or saturated. Nothing is added to the sample, and it may be returned to the process unchanged. Many corrosive or reactive gases can be analyzed.

COMPLETELY AUTOMATIC: Sampling and measurement are continuous and automatic. No attendant is necessary.

RUGGED CONSTRUCTION: The unit is shock mounted to protect it from extreme vibration and shock. Maintenance is negligible—no chemicals, filaments, wicks, etc., to replenish—no orifices or glassware to clean and replace.

MANY RANGES: From a few parts per million to 100% O_2. Multi-range instruments are also available.

measuring and control problems are welcomed. Please write ments of your particular directly to our head office giving data on the require- application.

For more information circle **53** on inquiry card.

DAVIS

Continuous combustible gas alarm systems

REMOTE HEAD AND TUBE SAMPLING TYPES

A complete line of Davis Gas Alarm Systems, together with a number of accessories, is available to meet varying requirements in protecting life, property, and processes against the explosive hazards of combustible gases and vapors in air.

They function by means of automatic continuous sampling of the flammable gas-air mixture, and give audible and visual signals when the gas concentration approaches dangerous limits.

Davis also offers special equipment designed to meet particular requirements or applications.

For complete information, write for Technical Bulletin 11-36.

INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS

A Division of Davis Emergency Equipment Co., Inc.

80 Holleck Street
Newark, N. J.

Progressive Manufacturers of Gas Analysis Instruments

For more information circle **54** on inquiry card.

NEW INSTRUMENTS

voltages cause light to climb up tube "the way a thermometer shows temperature." Has 30-in. leads made of 10,000-volt wire.—*Craft Laboratories, P. O. Box 606, Westfield, N. J.*

For more information circle **292** on inquiry card.

Distortion Meter

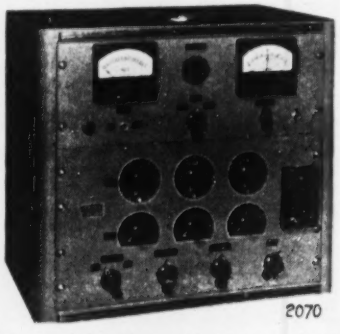
New "Model 1410 Distortion Meter" is said to represent "the most advanced instrument in its field." Fre-

quency range, 20 kc. to 1 Mc. in ten overlapping ranges. Distortion range, 0.1 to 30 percent. Input level range allows signal levels from 0.2 to 1,000 volts to be measured directly. Accuracy 0.1 percent at signal levels as low as 0.2 volts.—*Freed Transformer Co., Inc., 1715 Weirfield St., Brooklyn 27, N. Y.*

For more information circle **293** on inquiry card.

Cathode-interface Impedance Bridge

New "Model 270 Cathode Interface Impedance Bridge" is designed for measuring impedance of interface



layer which forms between nickel sleeve and oxide coating of unipotential cathodes; is direct-reading in ohms and microfarads.—*Pennsylvania Testing Laboratories, 30 E. Court St., Doylestown, Penna.*

For more information circle **294** on inquiry card.

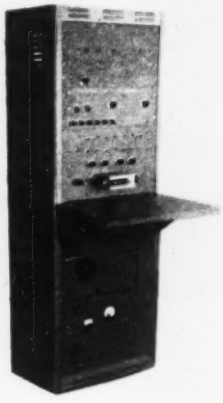
Tester Control Panel

New "Series CP Control Panel," for control of high-voltage power supplies in breakdown test equipment, is available as a standard RETMA rack-mounted unit, or as a self-contained cabinet model. A motor-actuated "Variac" uniformly increases voltage at rate of either 500 or 1000 volts per second.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **295** on inquiry card.

Magnetic Core Analyzer

New "Model MPT-1 Magnetic Core Pulse Analyzer," originally designed for testing square-loop magnetic-ma-



terial cores for high-speed memories, can be used for pulse evaluation of any magnetic materials. Among features: jig for rapid testing.—*Rese Engineering Inc., 301 Walnut St., Philadelphia 6, Pa.*

For more information circle **296** on inquiry card.

Hook-on Volt-ammeter

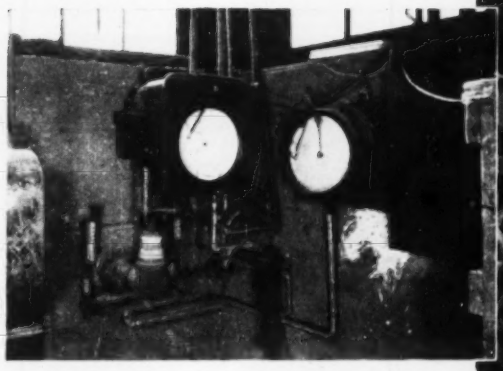
New "AK-5" hook-on volt-ammeter is believed to be first with automatic scale changing which eliminates

possibility of reading wrong scale. Ranges: 5/20/80/350 amp. and 150/300/750 v.ac. Accuracy to 3 percent of full-scale. Voltage breakdown test 4000 v.ac. Shock-resistant.—*Meter and Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

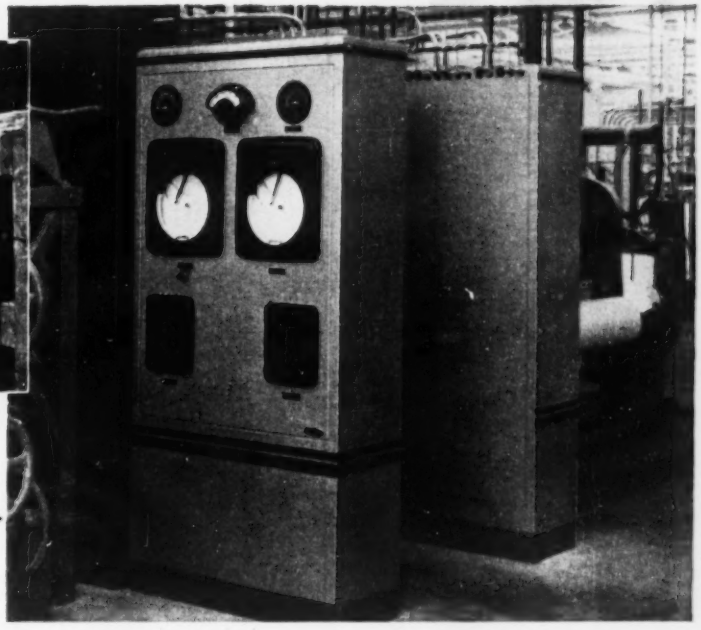
For more information circle **297** on inquiry card.

Capacitor-resistor Bridge

New "Model BF-60" capacitor-resistor bridge measures characteristics of substantially all types of capacitors



This is part of an old-fashioned installation which lacks the convenience and efficiency of modern instrumentation.

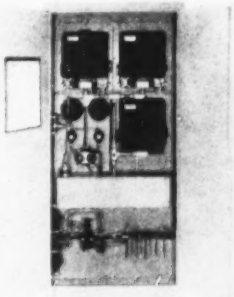


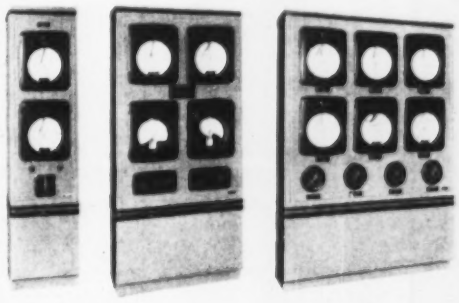
Compare this centralized Foxboro Cabinet installation of similar instrumentation, which saves time for the operator, makes his work more efficient, and gives maximum protection to the precision instruments required for his process.

See what a difference FOXBORO cabinet-mounting can make!

These photos show at a glance how much more efficient and attractive your instrument installation can be if it's integrated and centralized in a Foxboro Cabinet. Not only are the instruments protected from dust and process "atmospheres", but they're conveniently grouped together for more efficient use and easier maintenance. Those "endless steps" of the operator are a thing of the past!

Foxboro will supply a cabinet (or cabinets) to house and protect any number of existing instruments and related devices. Or your order for new instruments can be shipped to you already mounted in cabinets, completely piped and wired, needing only simple power and process connections to be put into operation. Write for illustrated and informative Bulletin 413.





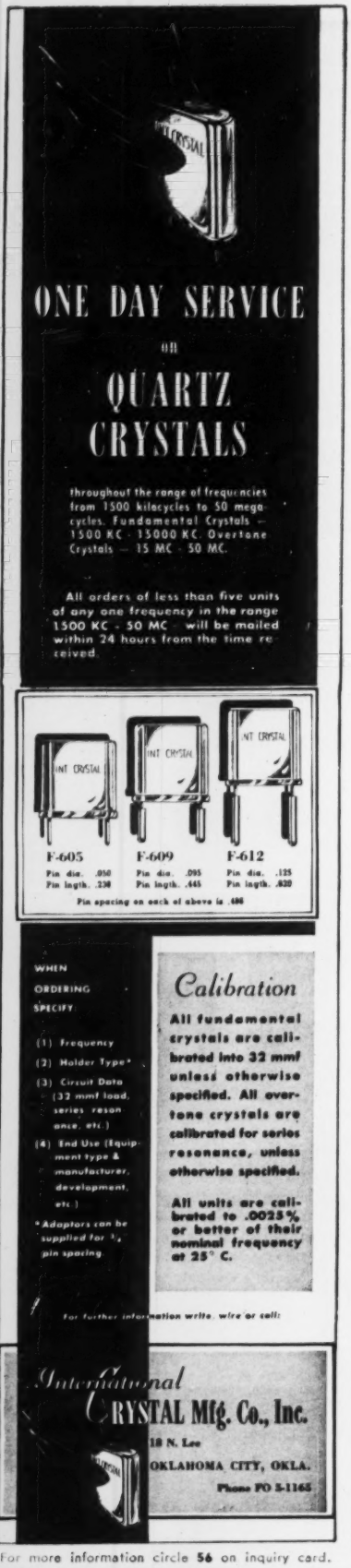
Foxboro Cabinets are available in three standard sizes for 2, 4, or 6 conventional-size instruments (or equivalent). For mounting more than 6 instruments, Foxboro Sectional Cabinets (with open ends) are used . . . bolted together to form desired length. End sections have one closed side to form dust-tight enclosure. Exclusive insert-type panel construction permits easy conversion when process changes so require.

THE FOXBORO COMPANY, 466 NEPONSET AVENUE, FOXBORO, MASS., U. S. A.

FOXBORO REG U S PAT OFF PROCESS CONTROL CABINETS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle 55 on inquiry card.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throughout the range of frequencies from 1500 kilocycles to 50 megacycles. Fundamental Crystals — 1500 KC - 15000 KC. Overtone Crystals — 15 MC - 50 MC.
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Pin lngth. .445
F-612
Pin dia. .125
Pin lngth. .620
Pin spacing on each of above is .486
WHEN ORDERING SPECIFY:
(1) Frequency
(2) Holder Type*
(3) Circuit Data (32 mmf load, series reson ance, etc.)
(4) End Use (Equipment type & manufacturer, development, etc.)
*Adaptors can be supplied for ½" pin spacing
Calibration
All fundamental crystals are calibrated into 32 mmf unless otherwise specified. All overtone crystals are calibrated for series resonance, unless otherwise specified.
All units are calibrated to .0025% or better of their nominal frequency at 25° C.
For further information write, wire or call:
International CRYSTAL Mfg. Co., Inc.
18 N. Lee
OKLAHOMA CITY, OKLA.
Phone FO 5-1165
For more information circle **56** on inquiry card.

NEW INSTRUMENTS

and resistors and determines their quality: detects opens, shorts and intermittents, capacitance between wires and shieldings, transformer windings, wires in cables, etc.; makes it possible to measure insulation resistance. Adjustable d-c. power supply and "eye" null indicator.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

For more information circle **298** on inquiry card.

ELECTRICAL INSTRUMENTS

Cathode-ray Oscilloscope

New "Type 329" is said to be a highly versatile and sensitive d-c. wide-band high-voltage oscilloscope. It provides: (1) high accelerating voltage necessary for high-brightness required to see and analyze pulses of low repetition rates or single transients; (2) stability and unchanging sensitivity necessary for accurate measurement. Among logical applications: electronic computer work, color TV, development of new industrial equipment, scientific and medical research.—*Instrument Div., Allen B. DuMont Labs., Clifton, N. J.*

For more information circle **299** on inquiry card.

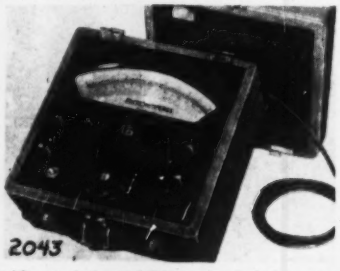
Potentiometer

New "Model 124 Precision D-c. Voltmeter" is a potentiometer using an adjustable reference voltage and a null indicator. It features two ranges of sensitivity; permits measurements to less than 10 mv. over a range of 0 to 510 volts; is useful for calibrating voltmeters, as well as for measuring small voltage differences.—*Furst Electronics, 3322 W. Lawrence Ave., Chicago 25, Ill.*

For more information circle **300** on inquiry card.

Electrical Indicating Instruments

New "Greibach Meters" incorporate a new moving coil suspension said to represent "the most radical meter improvement in over 50 years . . . practically eliminates friction, zero



drift and instability . . . does away with pivot bearings, coil and hair springs." Movement withstands 500-*G* mechanical shocks on all 3 axes and electrical overloads in excess of 100,000 percent. Many types and ranges such as light-beam pointer, multirange and differential instruments.—*Greibach Instruments Corp., Metuchen, N. J.*

For more information circle **301** on inquiry card.

True-rms. Voltmeter

New "Model 320" is said to be "the first commercially available voltmeter of the ultra-sensitive type to measure true root-mean-square values of highly complex wave forms" in addition to sinoidal waves. Range 100 microvolts to 320 volts in band of 5 cps. to 500 kc. Accuracy better than 3 percent between 15 cps. and 150 kc. for any reading regardless of scale position. Features include 10 megohm input impedance, provision for simultaneously observing voltage reading and monitoring amplified signal with phones or CRO, and calibrator unit for correcting effects of tube aging. Accessories are available for extending voltage range to 20 microvolts and 10 kv. and for measuring rms. currents from 0.1 microamp. to 10 amps.—*Ballantine Laboratories Inc., Boonton, N. J.*

For more information circle **302** on inquiry card.

Wave Analyzer

New "Model 20 Harmonic Wave Analyzer" for continuous coverage of frequency region from 50 cps. to 50 kc. is said to combine "small size, light weight, and low cost with high accuracy and sensitivity." A 1-percent second harmonic of 100 cps. may be measured with 5-percent accuracy. Double half-lattice crystal filter provides 3 db attenuation at 14 cps. and 40 db attenuation at 75 cps. off resonance.—*Donner Scientific Co., 2829 Seventh St., Berkeley 10, Calif.*

For more information circle **303** on inquiry card.

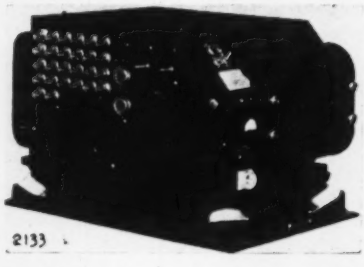
Frequency Meter

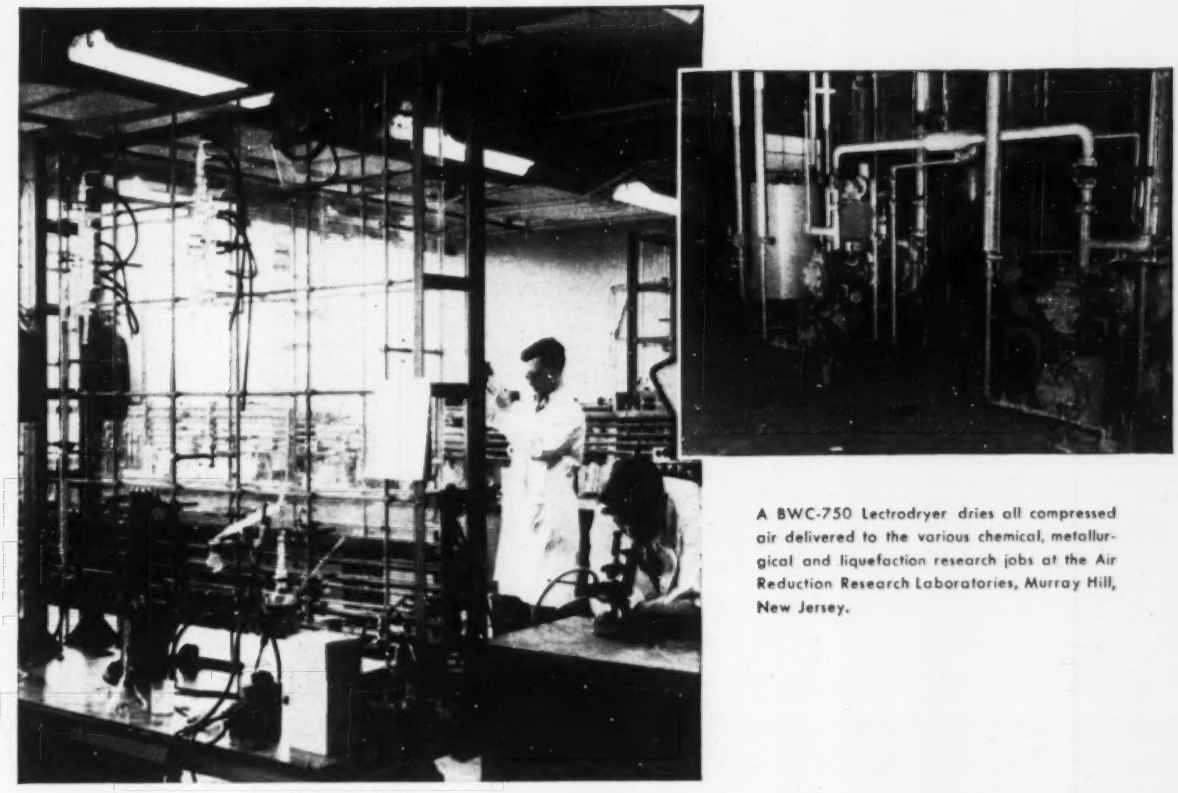
New "TS-175 A/U" frequency meter can be used as a Secondary Frequency Standard; covers range from 85 to 1000 Mc.; has 0.005-percent calibration accuracy and 0.0025-percent stability; is USAF approved. Environmental conditions passed: temperature: —55 C. to 85 C., humidity: 95 percent, altitude: 50,000 ft., fungus: 28-day incubation; also rain, sand, dust, vibration, shock and explosion-resistance tests.—*Colortone Electronics, Inc., 238 William St., New York 38, N. Y.*

For more information circle **304** on inquiry card.

26-trace Oscillograph

New 26-trace "Type 5-114 Recording Oscillograph" provides 44 percent additional data capacity but all standard features have been retained and size and weight have not been increased over those of the still-available 18-trace models. New "5-114" combines wide frequency-response range of maker's "Type 7-300" galvanometers with 0.45-to-115-ips. record-speed





A BWC-750 Lectrodryer dries all compressed air delivered to the various chemical, metallurgical and liquefaction research jobs at the Air Reduction Research Laboratories, Murray Hill, New Jersey.

Clean, DRY air is part of their formula at AIRCO ...

Air that's clean and DRY to a measured degree, won't upset the delicate compounding of chemicals and gases. In fact, clean DRY air is an ingredient which many times enables an experiment to succeed.

Air Reduction Research Laboratories obtain a constant supply of clean air at a preset low relative humidity by the combined use of a Lectrodryer* and Lectrofilter* installed at their air compressors. Perhaps you can benefit by a similar installation.

Lectrodryers can DRY air and gases in volume to dewpoints below −100° F. . . . can drop relative humidity lower than 10%. Lectrofilters remove dust, grime and compressor oil. These constant conditions are obtained continuously, automatically and economically.

If your research, production processes or manufacturing space require low relative humidity, learn more about types of Lectrodryers available. Write for *Because Moisture Isn't Pink*, a booklet describing the machines and how various industries use them to gain efficiency. Pittsburgh Lectrodryer Corporation, 330 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birm'ngham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
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LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

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For more information circle **57** on inquiry card.

For
PILOT LIGHTS
CONSULT
DIALCO

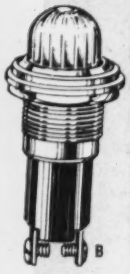
A

Your product benefits 3 ways from the use of a DIALCO Pilot Light:

Enhanced appearance: The glow of light and sparkle of a lens add colorful visual attraction.

Greater safety: A timely warning flashed by a pilot light can prevent damage to equipment.

Added service: Discs inserted behind lenses can be used to deliver specific messages, such as "FUEL LOW", "ON", "OFF", etc.


B

Let the Dialco engineering department assist you in selecting the *right* lamp and the *most suitable* pilot light for your needs.

Dialco offers the *complete* line of pilot lights, from sub-miniature types to giant units with 1½" lenses.

Every assembly is available complete with lamp.

SAMPLES ON REQUEST AT ONCE — NO CHARGE

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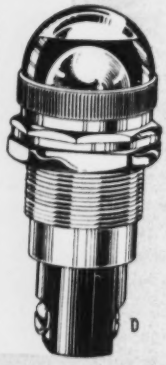
Illustrations are approx. 70% actual size . . . *(A)* No. 8-1930-111 sub-miniature pilot light . . . *(B)* No. 521308-991, with multivue cap . . . *(C)* No. 922210-111, dimmer type . . . *(D)* No. 47901 with light shield cap.

Write for Catalogues L-151, L-153, and L-154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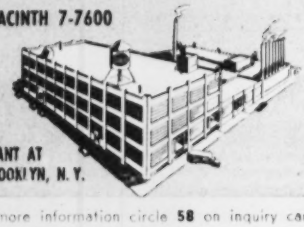


PLANT AT BROOKLYN, N. Y.

For more information circle **58** on inquiry card.

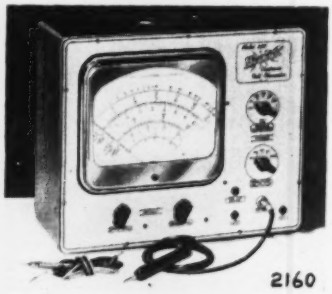
NEW INSTRUMENTS

range to record phenomena from static conditions to 3000 cps.—*Consolidated Engineering Corp., Pasadena 8, Calif.*

For more information circle **305** on inquiry card.

Electronic Volt-ohmmeter

New "Model 225 Electronic Volt-Ohmmeter" is designed around a 9-in. internal pivot indicator, offers new

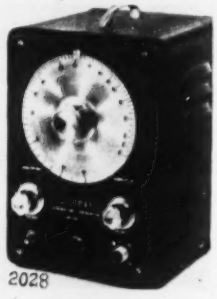

2160

features to improve speed of radio and TV servicing: extra-long scales; built-in audio tone; peak-to-peak scales for measurement of complex waveforms; d-c. zero-center scale for galvanometer applications; single-unit probe for both a.c. and d.c. through use of a slide switch.—*The Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio.*

For more information circle **306** on inquiry card.

Laboratory Oscillator

New "Model 10" laboratory oscillator gives continuous coverage of extremely wide frequency range from 1.8 cps. to 2.2 Mc. in six overlapping


2028

decades. Effective scale length 90 in. No zero setting required. Drift less than 2 percent including warmup. Mag.-amp. voltage regulation limits frequency error to 0.1 percent for 10 percent variation in supply voltage. —*Donner Scientific Co., 2829 Seventh St., Berkeley 10, Calif.*

For more information circle **307** on inquiry card.

UHF Grid Dip Meter

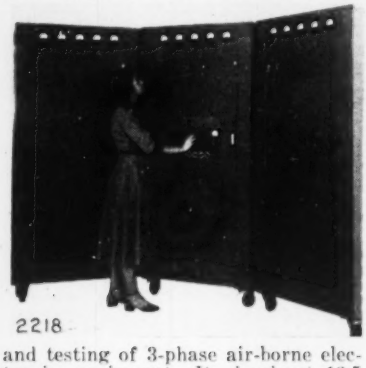
New "Model 101B UHF Grid Dip Meter" covers 300 to 1000 Mc. in three ranges: 300-425, 425-650, and 650-1000 Mc., employing three plug-in coils mounted externally on UHF probe, allowing ease of coupling to circuits to be measured. Dials individually calibrated. Innumerable applications in UHF field; can be used as an auxiliary signal generator, an

absorption wave-meter and as a means of determining many other factors in UHF circuitry. A 3-position switch enables it to be used in CW, modulated CW or as a detector. Carrier can be internally or externally modulated.—*Boonton Electronics Corp., Boonton, N. J.*

For more information circle **308** on inquiry card.

Variable-phase Generator

New "Model 1447" High-Powered Variable-Frequency Variable-Phase Electronic Generator was developed as a power source for development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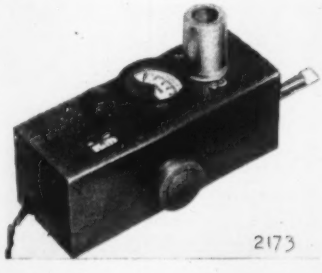
and testing of 3-phase air-borne electronic equipment. It develops 13.5 kva. of power into a resistive load through a frequency range of 50 to 6000 cps. Any desired phase relationship can be set up as the 3 outputs of its master oscillator have phase shift controls adjustable through 360 deg. —*Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N. J.*

For more information circle **309** on inquiry card.

UHF Grid-dip Meter

New "Model U-4" is a new type grid-dip oscillator-wavemeter for use in UHF-TV band. It covers 450-900-Mc. range. Tuning element uses a low-loss cavity resonated to desired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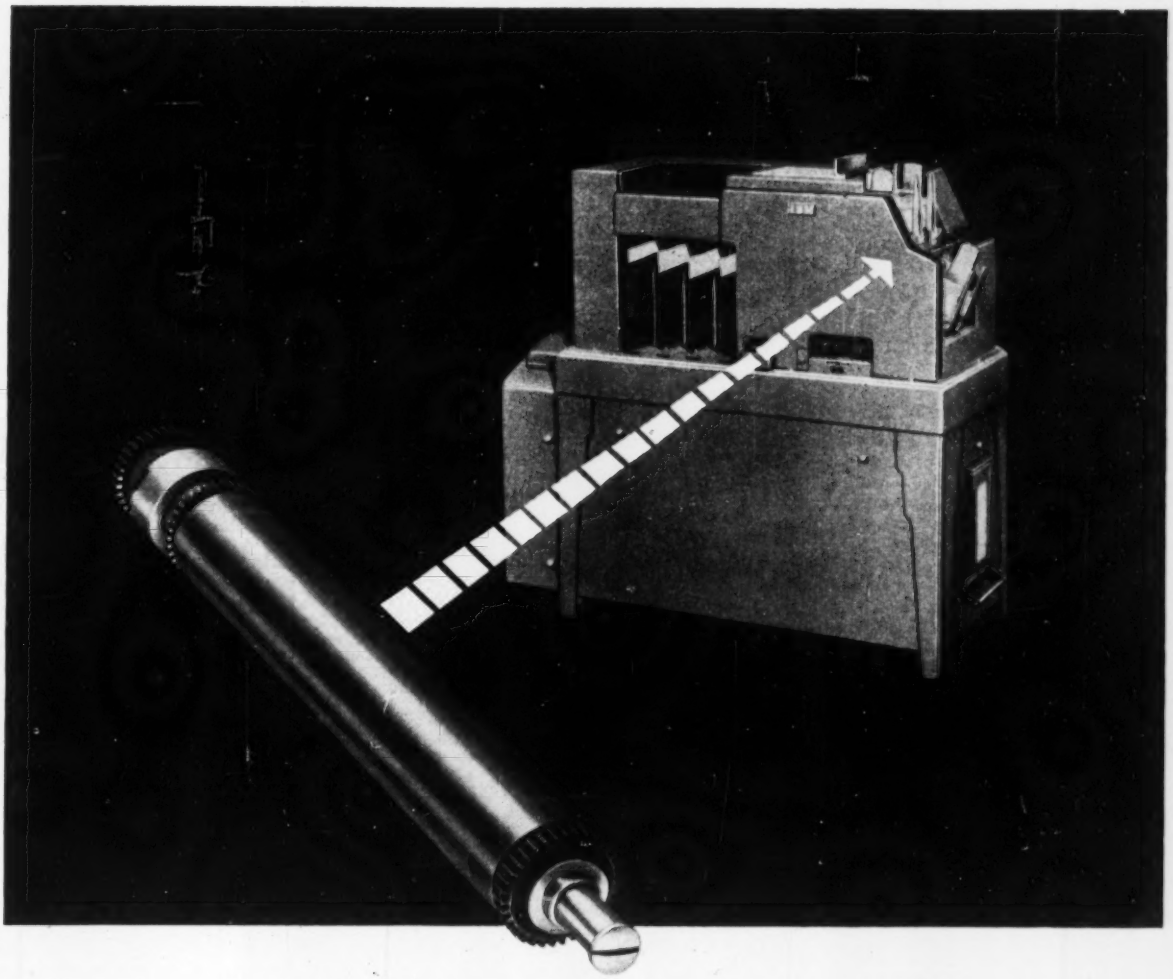

Out of IBM's Collator pops a tubing idea for you!

This is IBM's Collator—a mechanical super-accountant that shuffles, selects, matches and merges punched cards at the rate of four per second!

Heart of this electronic gee-whizzer is an extraordinary kind of tubing—a contact roll over which the cards must pass. Eighty miniature, hard steel brushes finger each card as it skims by—penetrate it through pre-punched holes, touch the contact roll and close the electronic circuit—flipping the card into the right slot.

Collator contact rolls must have good wear resistance to stand this high-speed workout. And they must resist corrosion and be good electrical conductors. So IBM employs Superior WELDRAWN* Beryllium Copper and low carbon steel composite tubing for Collator contact rolls. This tubing meets IBM's tight specifications for wear resistance, peak hardness and conductivity. Superior supplies the composite tube in 1⅛" O.D. with .049" wall.

When tubing troubles put the hex on your plans, call on Superior.

We have years of experience, the modern test and development facilities, and more than 55 analyses in many metals to unravel your problem. Write for a copy of our new Technical Bulletin #7-2 on Seamless and WELDRAWN* Beryllium Copper Tubing. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Round and shaped tubing available in Carbon, Alloy and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium

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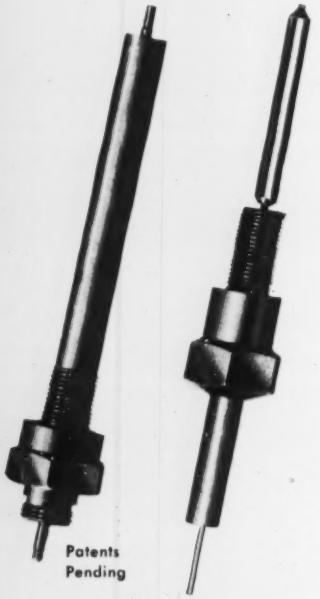
For more information circle **59** on inquiry card.

stop costly meter bearing replacement

- The price of one IIC Non-Freezing, Stainless Steel Bearing becomes your entire bearing cost.
- Many plants have had hundreds in use 3 to 5 years without service.
- Proved in the field for many years under the most severe operating conditions in all types of mercury flow meters and controllers, the advance-design IIC bearing is the answer to leaking, freezing, friction and corrosion. The IIC Instrument Bearing requires no lubrication—ever! Friction is reduced to the minimum, remains constant at high pressures. Requires no shaft end thrust, no adjustment. Installation is simple.
- The IIC bearing is manufactured as replacement for Brown, Emco, Foxboro and Metric meters and for many other special applications.
- WARRANTY: IIC Non-Freezing Bearings are guaranteed to give satisfactory service.
- This is not a Teflon Bearing.



Patents Pending

WRITE FOR BULLETIN 52-R

INDUSTRIAL INSTRUMENT CORP.
BOX 1909 ODESSA, TEXAS

For more information circle **60** on inquiry card.

NEW INSTRUMENTS

frequency by means of a split-stator type capacitor. No wiping or sliding contacts.—*Linear Equipment Labs., Brightwater Pl., Massapequa, L. I., N. Y.*

For more information circle **310** on inquiry card.

Vacuum-tube Voltmeter

New "Model 201" is a general-purpose laboratory or service vacuum tube voltmeter for measurement of d-c. or a-c. voltages, and resistances. Seven full-scale d-c. ranges of 1.5 to 1,500 volts at an impedance of 11 megohms. A-c. ranges are calibrated both in rms. values of sine waves (1.5 to 1,500 v. full-scale) and peak-to-peak values of 4 to 4,000 v.; separate scales. Resistances from 1,000 ohms to 1,000 megohms full-scale, in seven ranges; maximum accuracy at midscale, which is calibrated in multiples of 10 ohms for convenience. Standard probes include new "Illumi-probe" with a miniature lamp; also furnished is a set of "Klipzon" probes for resistance measurements. High-voltage and high-frequency probes are available as accessories.—*Shasta Div., Beckman Instruments, Inc., P. O. Box 294, Sta. A, Richmond, Calif.*

1844

For more information circle **311** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Slotted Line for L Band

New "Model SL-28 L Band Slotted Line," for region between 1120 and 1740 Mc., measures VSWR in Type

RG-69/U RG-103/U and other 6½ x 3¼-in. wave guides; permits amount of mismatch between line and load to be accurately determined, impedance of load to be obtained, and wavelength to be measured directly. Residual VSWR is less than 1.05 with probe at maximum insertion. Slope and leakage are negligible.—*Press Wireless Laboratories, Inc., 25 Prospect Place, West Newton 65, Mass.*

For more information circle **312** on inquiry card.

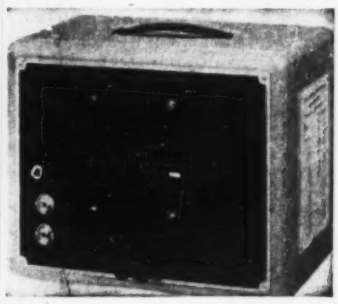
Single-sideband Filter

New "Type S-15000," single-sideband filter for amateur receivers utilizes a toroid coil instead of crystal filters formerly required; is similar to maker's SSB filters for commercial equipment. It utilizes 50 kc. as a 2nd IF and provides a narrow-band sharp-cutoff response.—*Burnell & Co., Dept. Z, 45 Warburton Ave., Yonkers, N. Y.*

For more information circle **313** on inquiry card.

Adjustable Phase Correction Unit

New "Cintel Adjustable Phase Correction Unit" permits phase correction at any stage in a development without laborious calculations. It per-



mits meeting requirements that amplitude response of an amplifier in a system should be constant and phase shift should be proportional to frequency.—*Dep't IM, Marconi Instruments Ltd., 23 Beaver St., New York 4, N. Y.*

For more information circle **314** on inquiry card.

Signal-marking Generator

New "Model E-200C" features higher frequency coverage: from 88 kc. to 240 Mc., 60 Mc. on fundamental

6½-in. dial, direct-reading in nine bands. Comes complete with tubes, output cable and copy of "Servicing By Signal Substitution."—*Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y.*

For more information circle **315** on inquiry card.

Frequency Multiplier

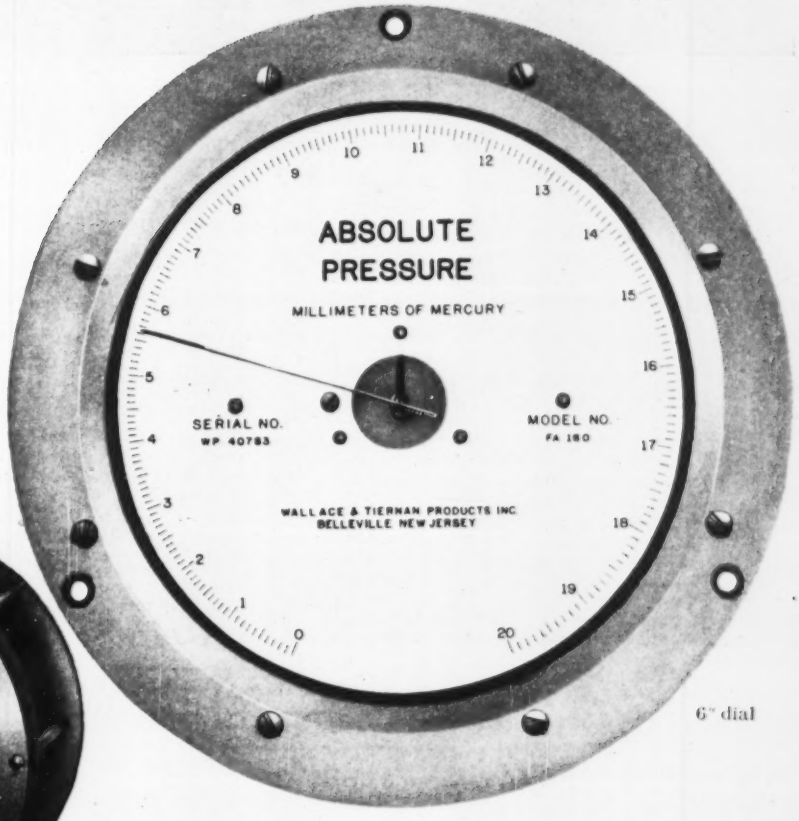
New "Model FM-4 Microwave Frequency Multiplier" measures and generates frequencies as high as 12,500 Mc., with continuous coverage. Frequencies as low as 100 Mc. measured by selecting a harmonic of unknown which falls within instrument's 500-1000-Mc. fundamental range and dividing by harmonic number. Accuracy and stability of output depend on external driver. If internal reference standard is used, "FM-4" contributes a maximum error of 0.00005 percent;

ABSOLUTE PRESSURE INDICATOR

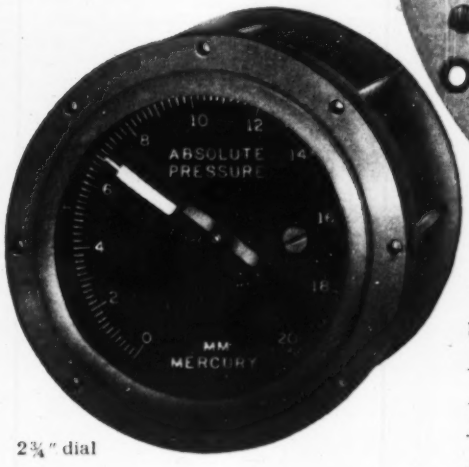
. . . FOR DEEP VACUUM WORK

Measures *pressure* directly from ZERO ABSOLUTE to atmospheric

. . . swiftly and precisely



6" dial



2¾" dial

Used as a pressure indicator in any system employing a vacuum.

- All readings are relative to ZERO ABSOLUTE.
- Dial *reads directly.*
- Accurate to 1 part in 300 over full scale.
- Sensitive to 1 part in 500 in *all* ranges.
- No auxiliary indicator or corrections for ambient pressure changes required.
- Protected against sudden pressure surges.
- Ranges:

0.1 – 20mm Hg.	0–200mm Hg.
0 – 50mm Hg.	0–410mm Hg.
0 –100mm Hg.	390–800mm Hg.

- Dial Sizes: All ranges in either 2¾" or 6" dia.

TYPE FA-160

For additional information on W&T Absolute Pressure Indicators, write today for Publication No. TP-28-A.

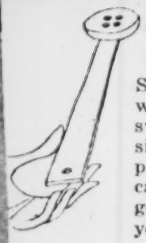
WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST. BELLEVILLE 9 N. J.
In Canada Wallace & Tiernan Ltd. Toronto

A-102

For more information circle **61** on inquiry card.

How to whip your relay problems!

Just call **ADVANCE...** *we're ready and willing to make the relays you need.*

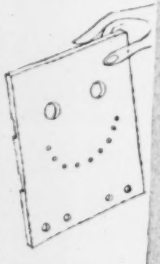


CONTACTS, *for example*

Say the word and we'll up the sizes... switch from fine silver to tungsten, palladium, silver-cadmium oxide, gold contacts, or... you name it!

INSULATION

Laminated phenolic, silicone glass, ceramic steatite, linen-base bakelite, or... you name it!



ANYTHING SPECIAL...,

ADVANCE will engineer, develop and produce the custom relays you need in minimum time. Call ADVANCE for action.

For **INDUSTRIAL USES**

We build a vast variety of rugged, reliable relays...create superior new designs quickly. You'll find our quality control is now the tightest in the industry.

Write—and let us solve your relay problems

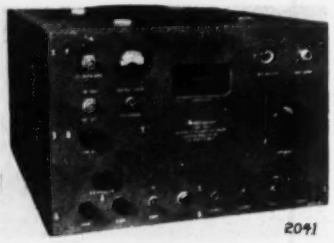
ADVANCE RELAYS

ADVANCE ELECTRIC AND RELAY CO.

2435-H NORTH NAOMI STREET
BURBANK, CALIFORNIA

For more information circle **62** on inquiry card.

NEW INSTRUMENTS



if an external reference is used, error contribution of "FM-4" is zero.—*Gertsch Products Inc.*, 11846 *Mississippi Ave., Los Angeles* 25, *Calif.*

For more information circle **316** on inquiry card.

'Scope and VTVM Probes

Five new probes are announced: three for oscilloscopes and two for vacuum-tube voltmeters, all with improvements for convenience, safety, and accessibility. Probe shells are color-coded.—*Electronic Instrument Co., Inc.*, 84 *Withers St., Brooklyn* 11, *N. Y.*

For more information circle **317** on inquiry card.

Dual-tone Filter

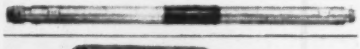
New "L-1569" dual tone filter, for use in muting units employed to silence radio commercials, contains two turnable circuits sealed in a MIL-T-27 can.—*Colin Campbell Co., Westville Ave., Extension, Danbury, Conn.*

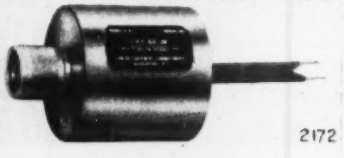
For more information circle **318** on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

UHF Transformer-balun

New "U-1, U-2 Transformer-Balun Combination" is a new impedance matching device for transforming out-





put impedance of an unbalanced source of voltage, such as a signal generator, noise generator or sweeper, to a balanced 300-ohm output. Covering 400-900 Mc. region, units facilitate measurements on UHF-TV band.—*Linear Equipment Labs, Inc., Brightwater Pl., Massapequa, L. I., N. Y.*

For more information circle **319** on inquiry card.

Delay Lines

New compact delay lines designed to fit specific needs, including color TV; can be obtained in tubular shape or package, with a wide choice of mountings. Delay can be varied from 0.01 to 1.6 usec. Characteristic impedance can be had from 400 to 2500 ohms. Wide frequency response: for instance, line with 0.5 usec. delay at 1200 ohms impedance, frequency response is 3 db down at 5 Mc., 6 db down at 8 Mc. and 10 db down at 10 Mc. Continuously-wound delay lines provide minimum pulse distortion and are thermally stable.—*Technitrol Engineering Co.*, 2751 *N. Fourth St., Philadelphia* 33, *Pa.*

For more information circle **320** on inquiry card.

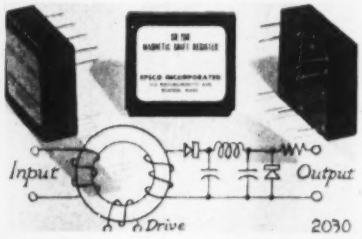
Ruggedized Triode

New "Type 6446 (water-cooled) triode for heavy-duty RF industrial applications is capable of dissipating 20 kw. continuously. High heat storage capacity is provided by 7/16-in. thick anode for heavy intermittent duty. Tube uses half of water flow required for type 892 for equivalent anode dissipation. Also available in air-cooled "Type 6447." New stem runs about 150 deg. cooler, minimizing thermal shock failure. New strong conical internal grid support instead of three-legged riveted construction. Rugged Kovar seal instead of copper "feather-edge" glass-to-anode seal. Stronger new helical filament provides more uniform heat distribution over anode surface.—*Amperex Electronics Corp.*, 230 *Duffy Ave., Hicksville, L. I., N. Y.*

For more information circle **321** on inquiry card.

Magnetic-storage Elements

New encapsulated magnetic storage elements serve also as shift registers and control elements replacing vacu-

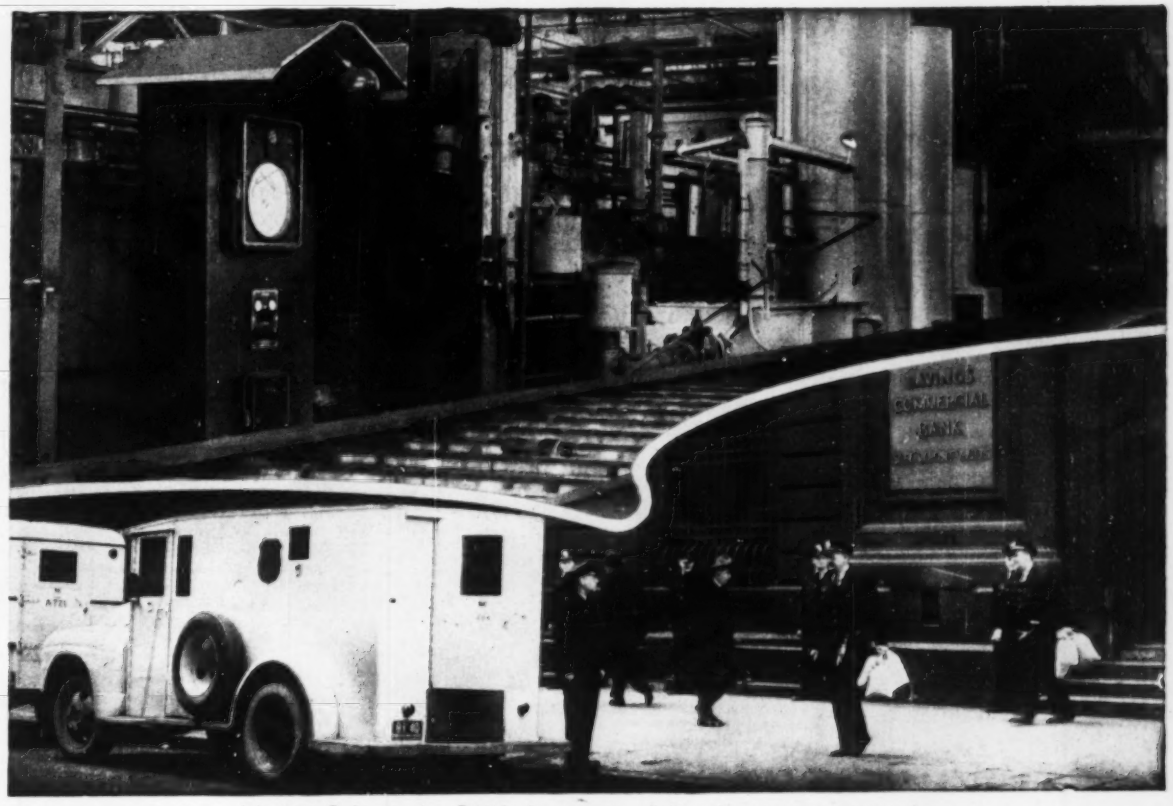


um-tube circuitry. Up to 50 can be driven by one tube. High-speed "Model SR-200" (illustrated) uses but one core per stored digit; works at rates up to 500 kc. Nominal shift current 300 ma.; output signal amplitude 15 volts.—*Epsco, Inc.*, 126 *Massachusetts Ave., Boston* 15, *Mass.*

For more information circle **322** on inquiry card.

Pulse Transformers

New standard and miniature hermetically-sealed pulse transformers for digital computer applications comprise two types: Miniature "Type



Modern Safeguards—Brink's for Money, Bailey for Process Materials

Are Your Process Materials Guarded As Well?

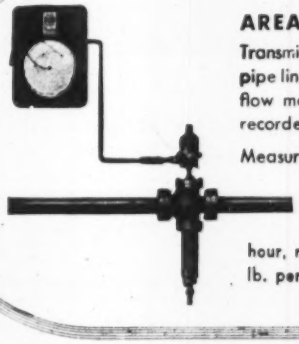
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials.



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 96,000 lb. per hour.

BAILEY METER COMPANY

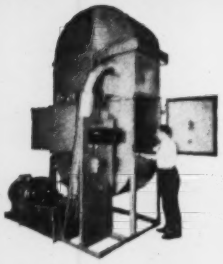
1041 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls
TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO

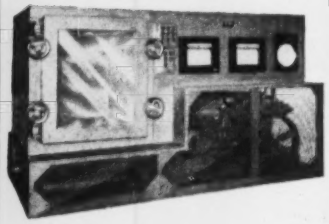
For more information circle **63** on inquiry card.

AR★

ENVIRONMENTAL TEST EQUIPMENT



SAND & DUST test chambers with completely automatic dust density control.



ALTITUDE chambers for testing from sea level to 100,000 ft. or higher with temperatures from —100° F to +200° F.

HUMIDITY chamber simulates relative humidity from 20% to 100% between +35° F and +200° F.

American Research Test Equipment can be designed and built in a variety of sizes and ranges to meet specific requirements.

Write for catalog.

AMERICAN RESEARCH CORPORATION
383 BROOK ST. BRISTOL, CONN.

For more information circle **64** on inquiry card.

NEW INSTRUMENTS

10Z" units, in ½-in. x ¾-in. cans, are primarily for use in circuits with pulse duration of 0.1 to 0.5 usec. Larger "Type 20Z" units are designed for applications requiring fast rise time with minimum pulse lag and decay, with pulses up to 20 usec.; "bathtub" cans 1¾ x 1¼ x ½ in.; chassis mounting ears available. Plug-in units, etc., manufactured to order.—*Sprague Electric Co., 43 Marshall St., North Adams, Mass.*

For more information circle **323** on inquiry card.

Sealed Multi-turn VDRs

New "Series H" multi-turn voltage-dividing resistors are nitrogen-filled and hermetically sealed. Diam. 1 in. Ten-turn and five-turn units available. Rotary seal design has been successfully tested at 100 psi. at —55 C. and at 100 C., and after 100,000 revolutions. Rating 4 watts at 40 C. Maximum torque (between 0 C. and 100 C.) 2 oz.-in.—*Ford Engineering Co., 129 East "A" St., Upland, Calif.*

For more information circle **324** on inquiry card.

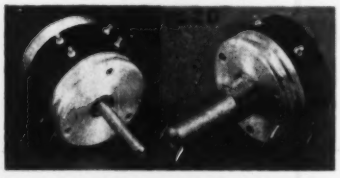
Precision VDR

New "Type 751" is third in a series of linear function voltage-dividing resistors featuring internal clamp ring construction for ganging cups. Linearity is 0.5 percent standard, 0.25 percent on special order. Rating 2 watts in single gang unit, 1.5 watts in dual ganged units, and 1 watt per cup section in multigang units. Torque 0.25 oz.-in. per cup; lower for special applications.—*Fairchild Camera & Instr. Corp., 225 Park Ave., Hicksville, L. I., N. Y.*

For more information circle **325** on inquiry card.

D-c. Sine-cosine VDRs

New "Model 106" (ball-bearing) and "106J" voltage-dividing resistors operate on either alternating or direct



current. Announcement states: ". . . the smallest packaged potentiometer ever produced which will perform the sine-cosine function at high impedance levels and without loss of resolution." Extremely high shaft velocities do not produce phase distortions or amplitude modulations. Sinoidal function is accomplished by a combination of mechanical-shaping and potential-field-distribution techniques applied to carbon film; transition from zero to finite slopes without abrupt steps in output; both sine and cosine outputs are produced simultaneously.—*Computer Instruments Co., 1964 Utica Ave., Brooklyn 34, N. Y.*

For more information circle **326** on inquiry card.

Tab-mounted Controls

New "LR5 Variable Resistors" are miniature low-cost "bushingless" controls for tab-mounting in receivers printed circuits, etc. Measuring 0.894 in. in diameter, new controls dissipate 0.5 watt; can be supplied with any of nine different line switches.—*Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.*

For more information circle **327** on inquiry card.

Welded-terminal Resistors

New all-welded terminal construction now covers maker's entire line of wire-wound resistors. Resistance wire is welded to terminal band, which itself is held permanently around core by means of welding. No soldering, brazing or mechanical fastenings.—*Ohmite Mfg. Co., 3601 Howard St., Skokie, Illinois.*

For more information circle **328** on inquiry card.

Ceramic Resistors

Two new styles have been added to "Castohm" coreless fixed wire-wound power resistors. New tab terminal resistors conform to MIL-R-10566. "Type R-29" has a rating of 12 watts based on a maximum hot spot temperature of 350 C. Maximum available resistance 10,000 ohms. "Type R-35" is rated at 60 watts for 350 C. hot spot. Maximum resistance 35,000 ohms.—*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **329** on inquiry card.

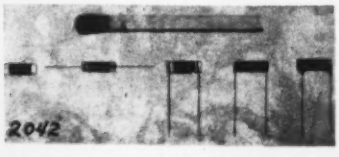
Encapsulated Resistors

New "RB Series" precision wire-wound resistors are hermetically encapsulated to exceed MIL-R-93A tests and to meet characteristic "A" of Jan-R-93. Protection is achieved against salt water immersion and humidity cycling. Process enables thermal cycling from —87 C. to 105 C. at full load, derate to zero wattage at 125 C. and still retain original characteristics within 0.05 percent. Resistance range 0.1 to 4 megohm; power ratings from ¼ to 1 watt. Tolerances to 0.02 percent.—*Reon Resistor Co., 117 Stanley Ave., Yonkers, N. Y.*

For more information circle **330** on inquiry card.

Subminiature Resistors

New "Glennite" subminiature resistors are especially suitable for transistorized assemblies; can be used individually in multiples, in packaged *R-C* circuits, or incorporated into



PRESSURE SWITCHES

• What they are • How they work • Where you use them

Front of Type VI Pressure Switch with ring, dial, and pointer removed. The back of the VI with cover removed is the same as the V Pressure Switch opposite with cover removed.

Type V Pressure Switch with cover removed

The USG Type V Pressure Switch consists essentially of a pair of micro-switches making or breaking contact in response to a pressure-sensitive element (bourdon spring).

Type VI has the same switch-operating pressure element as Type V but it has an additional bourdon spring connected to a pointer so that pressure can be read on a dial.

Pressure switches are used wherever a pressure warning signal must be given. Typical applications are: hydraulic pumps, hydraulic presses, die casting equipment, or guarding or controlling high or low tank pressures.

For information relating to your problem, call the United States Gauge office in your city or get in touch with us at Sellersville. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

CONSTRUCTION

TYPE V	**Case:**	Cast-iron case, back flange mounting, black crackle finish.
	Size:	4½" case only
	Bourdon Tube:	Beryllium copper or stainless steel
	Pressure Connection:	Lower only: ¼" male N.P.T. up to 1000 lbs. pressure; ½" male N.P.T. for 1000 lbs. and over.
	Electrical Connection:	½" female pipe conduit.
	Pressure Ranges:	Up to 10,000 p.s.i., vacuum to 30".
	Micro-switches:	High and low; rated 10 amps., 110 A.C., both fully adjustable over entire range of gauge.
	Switching Differential:	3%. Switches are not affected by overpressure.
TYPE VI		Same case construction, micro-switches, switch-operating elements, switching differential, pressure connections, electrical connections, and pressure ranges as Type V.
		Case has dividing wall between the separate bourdon springsystems foroperating the pointer and the micro-switches.
	Dial Sizes:	4½" and 6"
	Accuracy of Indications:	½ of 1% of the scale range.

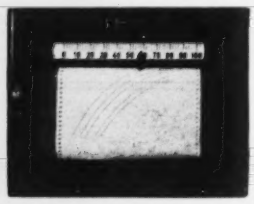
Quality Gauges Engineered for Enduring Accuracy UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges.

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

For more information circle **65** on inquiry card.

special ElectroniK recorders



function plotter

Automatically plots one variable directly as a function of another. One variable actuates the pen; the other, the chart drive. 11 inches full travel of both X and Y axis. See Data Sheet No. 10.0-5a.

duplex two-pen recorder

Simultaneously measures any two independent variables. Two separate measuring systems, each driving a pen which can traverse the full 11-inch chart. Any desired combination of ranges. See Data Sheet No. 10.0-6.

duplex function plotter

Two-pen version of the Function Plotter. Plots two different "X" variables as a function of a common "Y" variable. Wide selection of ranges for pens and chart measuring systems. See Data Sheet No. 10.0-17.

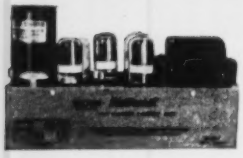
narrow span potentiometer

Measures spans as narrow as 100 microvolts, readable to 0.1 microvolt . . . needs no pre-amplifier. Available as a precision indicator, strip chart recorder, or circular chart pneumatic controller. See Data Sheet No. 10.0-8.

½-second recorder

Pen speed is only ½ second for full 11-inch chart travel. Improved velocity damping prevents overshoot. Chart speeds as fast as 4" per second are available. See Data Sheet No. 10.0-13.

components



amplifiers

For use with converter and balancing motor, for null detection and error signal correction. See Data Sheets 10.20-3a and 10.20-4.

Amplifier No.	Input Impedance (ohms)	Sensitivity* (volts)	Overall Voltage Gain
357504-20	80,000	3×10^{-6}	1×10^{6}
357504-21	80,000	1×10^{-6}	3×10^{6}
357504-5	400	4×10^{-6}	1×10^{6}
356899	2,200	$.05 \times 10^{-6}$	40×10^{6}

*Approximate sensitivity, when used with motors listed below.

balancing motors

2-phase induction, reversing

Totally enclosed, self lubricated. High torque at low speeds. See Data Sheet No. 10.20-2b.

Ratings for 115 volt, 60 cycle operation†				
Shaft Speed, rpm	27	54	162	333
Maximum Torque, inch-ounces	85	43	19	11
Intermittent Rated Torque, inch-ounces	30	15	5	4
Maximum Power, inch-ounces per minute	6300 at 17-18 rpm	6700 at 35 rpm	8150 at 100 rpm	8750 at 190 rpm
Power Required, all speeds	Line Field, 9.5 watts Amplifier Field, 4 watts			

†Motors for 25 and 40 cycle service are also available. Above motors may be used on 50 cycles.

converters

Proved by years of service in *ElectroniK* recorders. Convert low power d-c signals to alternating voltages at nominal frequencies of 25, 40, 60 or 400 cycles. For null detection or error voltage measurement. Extremely low thermal emf; thorough shielding against pickup. See Data Sheet 10.20-1.

Electrical Characteristics of 400 cycle Converters (60 cycle converters similar except as noted)

Driving Coil Input: 18 volts, 94 milliamperes, 400 cycles (within 10%). (60-cycle model: 6.3 volts, 60 ma.)

Contact Rating: SPDT switching. Nominal rating 6 volts to 1 microvolt. 1.0 milliampere, maximum power, 100 microwatts.

Symmetry: Within 5%.

Vibration Resistance: Output voltage varies less than 2% under accelerations up to 10 g.

Stray Pick-up: Electrostatic: 2×10^{-10} volts per ohm of input circuit impedance. Electromagnetic: 2×10^{-9} volts, constant to 2×10^{-6} volts.

For more information circle 66 on inquiry card.

adjustable span recorder

The instrument of a hundred ranges. Calibrated dials on front of the case permit adjustment of span from 1 to 50 millivolts . . . shift of zero by plus or minus 100% of maximum span. See Data Sheet No. 10.0-10.

high impedance recorder

Records data from sources having impedance ranging from 0 to 50,000 ohms, with negligible loading effect on source. Spans down to 2 mv. Excellent stray rejection. See Data Sheet No. 10.0-14.

ElectroniK null indicator

The modern successor to the galvanometer is this electronic d-c null balance detector. Needs no special mounting. Vibration-resistant, stable and fast. Takes heavy overloads; no "loss of spot." Sensitivity 0.6 x 10^{-9} amp millimeter. See Data Sheet 10.0-12.

Instruments and Servo Components

for research work

YOUR own research program can be accelerated through the use of these and many other *ElectroniK* instruments, Brown Electronic Components and special primary elements. Your nearby Honeywell field engineer will be glad to consult on your specific requirements. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

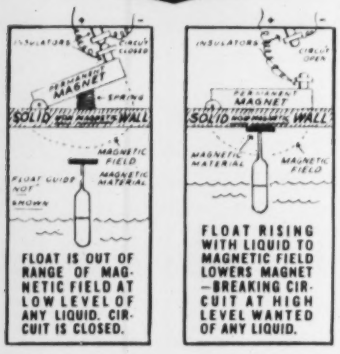
For more information circle **66** on inquiry card.

Invisible MAGNET
power through stainless steel wall controls liquid level you want without fail—ever.

NEW
LEVEL-MASTER
for all liquid level control is SAFE and SURE

- No leaky connections
- No complex construction
- No maintenance
- No explosion hazard

MAGNETIC PRINCIPLE works "*Naturally*" like this


SOLID
MAGNETIC FIELD
MAGNETIC MATERIAL
FLOAT GUIDE NOT SHOWN
FLOAT IS OUT OF RANGE OF MAGNETIC FIELD AT LOW LEVEL OF ANY LIQUID. CIRCUIT IS CLOSED.
FLOAT RISING WITH LIQUID TO MAGNETIC FIELD LOWERS MAGNET—BREAKING CIRCUIT AT HIGH LEVEL WANTED OF ANY LIQUID.

Switch action can be reversed for low and high level control and used also for single pole double throw switch.

Use the coupon now for complete information. There is a LEVEL-MASTER for every application—for every liquid. The LEVEL-MASTER is compact and can be mounted on the side—on the top—or externally. Can be used on both closed and open tanks. Operates at all liquid temperatures, pressures and gravities.

And—prices start at only $37.50. Write today for illustrated literature and price list.

Sales franchises available for some territories—write

Jo-Bell Products, Inc.
4842 So. St. Louis Ave.
Chicago 32, Illinois
Please send me LEVEL-MASTER literature and price list.
Name_____
Company_____
Address_____
City_____

For more information circle **67** on inquiry card.

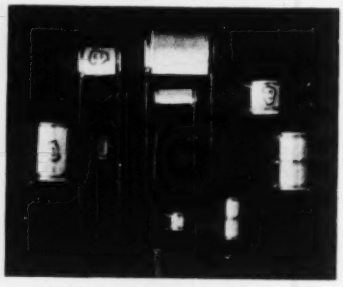
NEW INSTRUMENTS

printed networks. Units are cut to size and resistance after being cured, hence may be evaluated before insertion into a packaged or printed circuit.—*Glenco Corp., Metuchen, N. J.*

For more information circle **331** on inquiry card.

Non-inductive Resistors

New "K-F Precision Resistors" are available in exact resistance values to accuracies of 1, 0.5, and 0.1 per-



cent; in standard value ranges from 0.1 ohm to 1 megohm; are wound non-inductively on non-hygroscopic ceramic bobbins and impregnated for moisture protection. Temperature coefficient 0.000025 ohms/deg.C. Power ratings from ¼ watt to 1 watt.—*K-F Development Co., 2667 Spring St., Redwood City, Calif.*

For more information circle **332** on inquiry card.

Insulated Chokes

Two new sizes are added to maker's insulated choke line; are available in four sizes all protectively insulated against high humidity in molded plastic housings. "Types CL½, CLA, CL1, and CL2" offer a wide range of size and characteristic combinations.—*International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.*

For more information circle **333** on inquiry card.

Tubular Capacitors

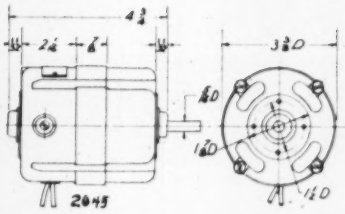
New "Type G-6 Glascaps" glass tubular plastic dielectric capacitors feature light weight and compactness not attainable in other types of capacitors; are particularly useful in high-voltage d-c. and low-frequency low-voltage a-c. applications; are available in ratings from 0.01 uf. at 600 volts through 0.0015 uf. at 60,000 volts. Immediate delivery.—*Corson Electric Corp., 540 39th St., Union City, N. J.*

For more information circle **334** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Instrumentation Motor

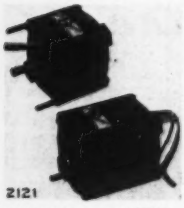
New "Model 512" series motor (also available as a shunt motor) is made in both open or closed construction. Optional features: internal fan, 10 different gear units with a wide range of ratios, automatic governor controls for two-speed, single-speed or



adjustable-speed; automatic or manual motor protector; motor mounted on base or face. Hp.: 1/10 continuous, 1/5 intermittent. Various voltages and rotations.—*Howard Industries, Inc., Racine, Wis.*

For more information circle **335** on inquiry card.

Fractional-hp. Motors



New "Borg-Motor" is said to be "a new type of electric motor." Units are totally-enclosed; are offered in 2- or 4-pole synchronous or induction types in ratings of 1/2,000, 1/1,500, 1/1,000 or 1/750 hp. (power dissipated within safe temperature rise); with or without internal gear train. Standard units are for operation on 115 v.ac.; special voltages and frequencies to order.—*The George W. Borg Corp., 120 So. Main St., Janesville, Wisc.*

For more information circle **336** on inquiry card.

Synchronous Motor

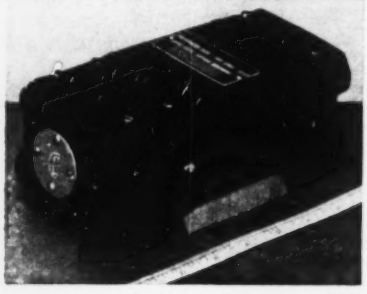
New "RBCP-2510" polarized synchronous motor always pulls into synchronous speed with rotor in same

position with respect to polarity of motor field; is rated 0.3 oz.-in. torque, 3600 rpm., continuous 40 C. rise for use with 115 v.ac. 12 watts input. Typical application, driving instrument dc.-ac. chopper.—*Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., 125 Amory St., Boston 19, Mass.*

For more information circle **337** on inquiry card.

Motor-generator

New "Duovolt Genemotor" is a 6- and-12-volt power supply for operating mobile radio equipment; incor-



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The distinctive WESTON fan shape contributes more than just *long scale* readability and attractive instrument design. Its pleasing lines enhance overall equipment appearance, and the long scale opening compels the eye and conveys an instant impression of measurement authority.

Fan shape instruments are available in four sizes, scale lengths from 2.6" to 7.32", as d-c voltmeters, ammeters and milliammeters. *Also for special instrument needs, with any required scale markings* such as RPM, feet per minute, pounds of effort, depth, etc. Send for special bulletin giving specifications and prices . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey. 6918

WESTON *Instruments*

For more information circle 68 on inquiry card.

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For more information circle **69** on inquiry card.

TANK-O-METER

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TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM

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For more information circle **70** on inquiry card.

porates two separate 6-v. input windings, each having its own field. —*Dep't 20, Carter Motor Co., 2644 N. Maplewood Ave., Chicago 47, Ill.*

For more information circle **338** on inquiry card.

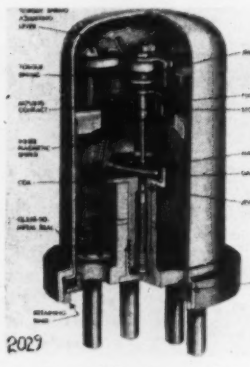
P-m. D-c. Motor

New "Type DC-8-A-1" permanent-magnet d-c. motor, for airborne navigational, fire control and photographic equipment, is designed for 28-volt operation (other voltage ratings available). No-load speed 25,000 rpm.; minimum stall torque 1.0 oz-in.; useful power at shaft exceeds 6 watts at 12,000 rpm.; maximum efficiency exceeds 70 percent.—*Clifton Precision Products Co., Inc., Marple at Broadway, Clifton Heights, Penna.*

For more information circle **339** on inquiry card.

Sensitive Relay

New "Model 219" is said to be "capable of operating in previously unobtainable low-power ranges"; on input powers of 25 microwatts in

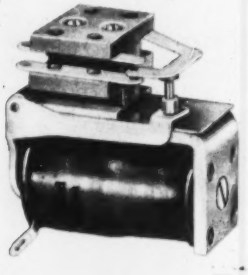


standard models or as low as one microwatt in special cases. It operates directly from photocell and thermocouple outputs and can be used in plate and grid circuits.—*Instrument Div., Thomas A. Edison, Inc., West Orange, N. J.*

For more information circle **340** on inquiry card.

R-f. Circuit Relay

New "MC" relay with high dielectric ceramic insulation and inter-contact capacitance in the order of 1.5 mmfd. is especially applicable to r-f. circuitry where inter-contact capacitance losses are critical. It is available with a maximum of three movable and three fixed arms giving any allowable arrangement of Form A, B or C. Contacts are of pure palladium rated 1 amp., 28 v.dc. or 115 v.ac. non-inductive load. Gold alloy contacts may be supplied on order to handle low-voltage, light-current loads.—*Potter & Brumfield, Princeton, Indiana.*



For more information circle **341** on inquiry card.

Miniature Sealed Relay

New "Type MRH" miniature relay for aircraft and missile application weighs 1.4 oz.; is useful at 50-*G* shock and 20-*G* vibration up to 500 cps.; 2-amp. contacts in d.p.d.t. combination; for use at ambients of 85 C. (up to 200 C. for special purposes); coil resistances up to 10,000 ohms. Units can be supplied as plug-in, or new ferrule mounting. —*Branson Corp., Boonton, N. J.*

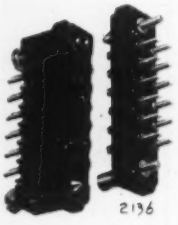
For more information circle **342** on inquiry card.

Relay Control Box

New "Electronic Relay Control Box" suitable for controlling motors, constant temperature baths, ovens, etc., is assembled into a die-cast aluminum housing, features an isolating transformer, 2D21 vacuum tube, and 1500-watt heavy-duty relay. Control circuit requires 5 microamperes. A 2-position switch puts the relay in n-o. or n-c. position without re-wiring. Plug-ins for load and connectors for control circuit are provided.—*Labline, Inc., 217 N. DesPlaines St., Chicago 6, Ill.*

For more information circle **343** on inquiry card.

Power Connectors



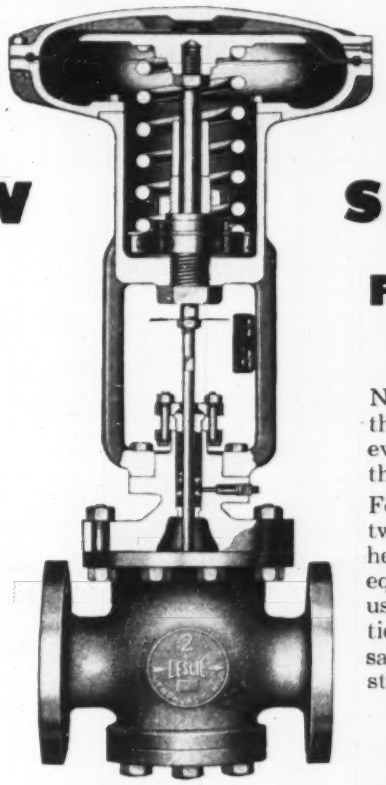
New "Series E-Z 16" connectors with bayonet locks insure against accidental disconnection. Bayonet lock also acts as self-aligning guide pin and polarity guide socket. Available in 12, 18, 24, and 34 contacts.—*Electronic Sales Div., De-Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

For more information circle **344** on inquiry card.

Double-break Switches

New "TB Series" double-break switches, for controlling two isolated circuits, use a snap-action spring for almost simultaneous break and make of both contacts in both n-o. and n-c.

something **SPECIAL** in a **STANDARD** control valve...

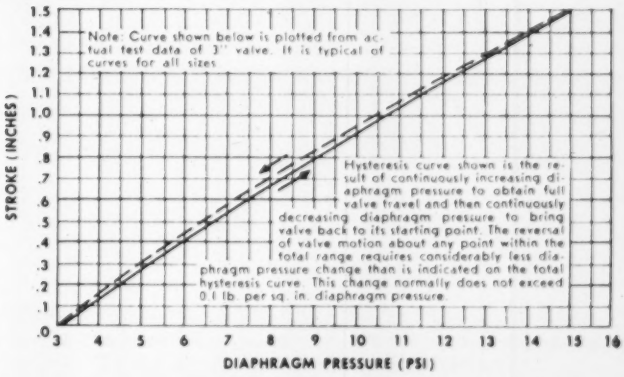


NEW SUPERSTRUCTURE

FOR LESLIE DIAPHRAGM CONTROL VALVES

Now standard for *all* Leslie Diaphragm Control Valves, this new rugged, precision stroke, superstructure means even more reliable performance than the high level set in the past by Leslie.

For instance, linearity (the straight line relationship between diaphragm pressure and inner valve movement) is held to plus or minus 2% for valve strokes up to 1½"—equivalent to .020" for valves with 1" stroke without using valve positioner. Hysteresis, the difference in position of the inner valve on the up and down strokes for the same diaphragm pressure, is held to 2% of full valve stroke for travel up to 1½". Here is the curve.


Note: Curve shown below is plotted from actual test data of 3" valve. It is typical of curves for all sizes.
Hysteresis curve shown is the result of continuously increasing diaphragm pressure to obtain full valve travel and then continuously decreasing diaphragm pressure to bring valve back to its starting point. The reversal of valve motion about any point within the total range requires considerably less diaphragm pressure change than is indicated on the total hysteresis curve. This change normally does not exceed 0.1 lb. per sq. in. diaphragm pressure.
STROKE (INCHES)
1.5
1.4
1.3
1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0
3 4 5 6 7 8 9 10 11 12 13 14 15 16
DIAPHRAGM PRESSURE (PSI)

Only Leslie gives you all of these "made-to-order" advantages in a standard valve.

- ✔ Full-flow, smoothly contoured body
- ✔ Renewable, interchangeable seat rings
- ✔ Bolted stuffing box
- ✔ Molded rings or Teflon packing
- ✔ Thermo-isolating bonnet
- ✔ Accurate part replacement from name plate data
- ✔ Stem flats for ease of connection

Send for
Bulletin 5304 (Single Seated Diaphragm Control Valves)
Bulletin 5305 (Double Seated Diaphragm Control Valves)

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REGULATORS SINCE 1900
STILL FAR AHEAD IN QUALITY AND PERFORMANCE

LESLIE CO., 299 Grant Avenue, Lyndhurst, New Jersey

For more information circle **71** on inquiry card.

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Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

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MERCURY ACTUATED
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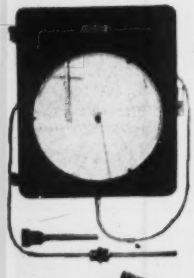

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INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

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Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

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For more information circle **72** on inquiry card.

NEW INSTRUMENTS

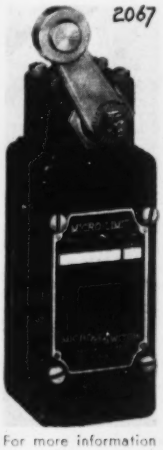
circuits; feature small size (½ x ½ x 1¼ in.) and two screw terminals (n-o. and n-c.) extending from either end of phenolic case and plated for soldering for applications in which screws are not used. Rating 10 amps. at 125 or 250 v.ac. and 10 amps. at 30 v.dc. inductive.—*Micro Switch, Freeport, Ill.*

For more information circle **345** on inquiry card.

Excess-vibration Switch

New "Vibraswitch" actuates an alarm or shuts down a machine in event of excess vibration, which may mean either a violent shaking or a higher frequency noise transmitted through structure and barely detectable by touch. An adjustment prevents actuation when machine is functioning with normal vibration. Device must be reset by hand to restore normal operation after actuation; requires no damping means; is insensitive to temperature variations. Announcement states: "We know of no alternative means of obtaining the same results except through the use of a vibration sensing transducer, an amplifier, a sensitive relay, and a d-c. power supply. Such a combination would cost hundreds of dollars and require considerable maintenance."—*The Beta Corp., P. O. Box 8625, Richmond 26, Va.*

For more information circle **346** on inquiry card.



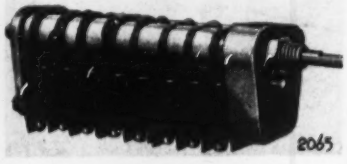
Heavy-duty Limit Switch

New "101ML1" two-circuit heavy-duty limit switch uses snap-action spring for simultaneous make and break of both contacts (of both n-o. and n-c. circuits); features a field adjustable roller-arm actuator; is rated for 10 amps. 110, 220 or 440 v.ac. and has a pilot duty rating of 6 amps. 125 v.ac.—*Micro Switch, Freeport, Illinois.*

For more information circle **347** on inquiry card.

Rotary Selector Switches

New subminiature rotary selector switches are available with from two to eight switching units and from two

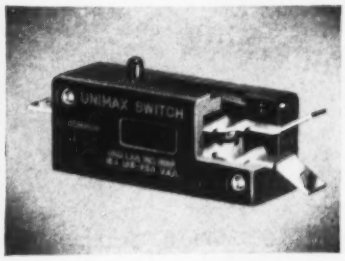


to eight detent positions, with a 45-deg. angle between detents. Virtually any switching sequence is possible.—*Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

For more information circle **348** on inquiry card.

Snap-acting Switch

New "Type WL" snap-acting switch, having maximum ease of installation, rated at 15 amps, 125/250

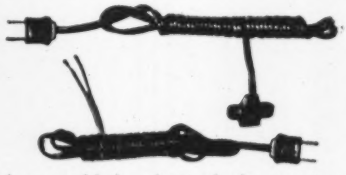


v.ac.; features quick-connect terminals.—*The W. L. Maxson Corp., 460 W. 34th St., New York 1, N. Y.*

For more information circle **349** on inquiry card.

Line Cords

New "US-YR-Cord" a-c. line cords and molded plastic line cord sets are supplied with molded or attached

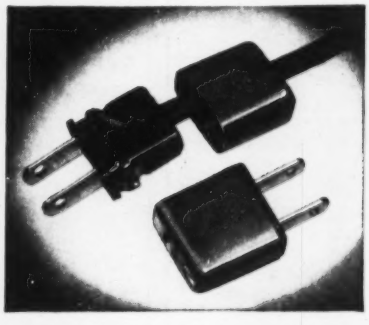


plugs, molded and attached connectors, molded crotches, harnesses, and other special types of construction.—*U. S. Wire & Cable Corp., Progress & Monroe Sts., Union, N. J.*

For more information circle **350** on inquiry card.

Line Cord Plug

New "Cat. No. 1420", developed for military applications, is made of unbreakable nylon; has molded-in strain



relief for line cord; is smallest replaceable plug commercially available.—*Industrial Devices, Inc., Edgewater, N. J.*

For more information circle **351** on inquiry card.

POWER SUPPLIES

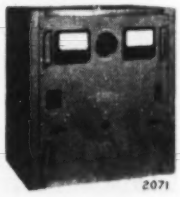
Strain-gage Supply

New "Model 125 Strain-gage Terminal" for use with maker's "Model 220 Wide-band D-c Amplifier" or other instruments with differential input, contains a metered voltage source

to energize resistance strain gages; provisions to obtain initial balance of strain gage bridge circuit as well as a number of precision resistors which may be used to complete bridge circuit if fewer than four external strain gages are used; selector switch for these resistors in any one of three common circuits.—*Furst Electronics, 3322 W. Lawrence Ave., Chicago 25, Ill.*

For more information circle **352** on inquiry card.

Mag.-amp.-reg. D-c. Supply

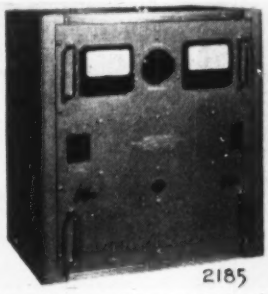


New "Model No. MR1040-30" 30-amp. power supply, added to maker's standard line of magnetic-amplifier-regulated power supplies, is rated at 10-40 volts at 30 amps. continuously; has regulation accuracy of 1 percent (a) from 10 to 40 v.dc., (b) from 100 to 130 v.ac., (c) from 3 to 30 amps.; ripple 1 percent rms. It is designed for input of 100 to 130 v.ac. Response time 0.2 sec. maximum and response is independent of output voltage setting.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **353** on inquiry card.

Mag.-amp.-reg. Power Supply

New "Model No. MR1040-30" magnetic-amplifier-regulated power supply is rated at 10-40 volts at 30 amps.

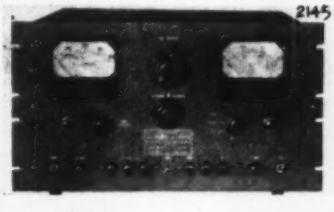


continuously; has 1 percent regulation accuracy (a) from 10 to 40 v.dc., (b) from 100 to 130 v.ac., (c) from 3 to 30 amps.; response time 0.2 sec. maximum; response independent of output voltage setting.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **354** on inquiry card.

D-c. Power Supplies

New "Regatron" models provide, each in one unit, a variable d-c. voltage standard, a high-powered regulated power supply, and a research voltage source with small signal mod-



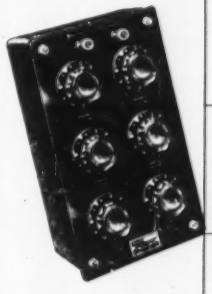
DECADE RESISTANCES & VOLTAGE DIVIDERS

delivered from stock

Accuracy: 10 ohms and above: ±0.1%
1 ohm: ±0.25%
0.1 ohm: ±1%
0.01 ohm: ±5%

Temp. Coeff.: ±0.002% per degree C.
Maximum Load: ½-watt per step
Frequency Limit: Non-inductive to 20KC

DECADE RESISTANCE BOXES

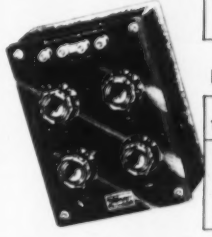


Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
817	3	0.01	11.1	$60.00
818	3	0.1	111	51.00
820	3	1	1,110	56.00
821	3	10	11,100	60.00
822	3	100	111,000	63.00
823	3	1,000	1,110,000	77.00
824	3	10,000	11,100,000	120.00
817-A	4	0.01	111.1	75.00
819	4	0.1	1,111	71.00
825	4	1	11,110	77.00
826	4	10	111,100	79.00
827	4	100	1,111,000	92.00
828	4	1,000	11,110,000	139.00
8285	5	0.1	11,111	94.00
829	5	1	111,110	101.00
830	5	10	1,111,100	113.00
831	5	100	11,111,000	155.00
817-C	6	0.01	11,111.1	105.00
8315	6	0.1	111,111	109.00
832	6	1	1,111,110	121.00
833	6	10	11,111,100	169.00

UNMOUNTED DECADE RESISTANCES

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
435	1	0.1	1	$12.00
436	1	1	10	13.25
437	1	10	100	13.25
438	1	100	1,000	15.00
439	1	1,000	10,000	16.00
440	1	10,000	100,000	18.50
441	1	100,000	1,000,000	32.50
442	1	1,000,000	10,000,000	60.00

DECADE VOLTAGE DIVIDERS (Potentiometers)



Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
845	3	1	1,000	98.00
837	4	0.1	1,000	126.00
835	4	1	10,000	132.00
836	4	10	100,000	146.00

SHALLCROSS MANUFACTURING COMPANY

Pusey and Lincoln Aves., Collingdale, Pa.

Shallcross

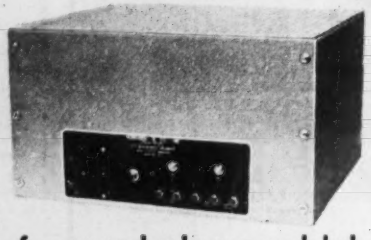
Our 25th Year 1929 1954

For more information circle **73** on inquiry card.

The Beckman Model DU is considered the key precision instrument for spectrophotometric analysis—a technique which is fast revolutionizing the fields of investigative and control chemistry.
Based on the spectral light characteristics of liquids, solids and gases, precision spectrophotometry quickly and accurately analyzes thousands of varied materials, both qualitatively and quantitatively . . . providing data which is vital for accurate, economical product and process control.

Whatever the material — be it orange juice, metal alloys, lubricating oils, fertilizers or vitamins—chances are you'll find modern spectrophotometry playing a key role in its efficient and economical production, processing or control.

here's the



IDEAL POWER SOURCE

for your beckman model du quartz spectrophotometer

The Sorensen Model E-6/2-5 Nobatron, With Regulation Accuracy of ±0.01%, Gives Stability of Batteries With None of the Disadvantages.

When you use a Beckman Spectrophotometer you expect the *utmost* in performance. And you get it—so long as the power supply is dependable.

The Sorensen Model E-6/2-5 Nobatron *is dependable.* It has been specifically designed to provide your Beckman with 2 and 6 volts DC, *plus or minus 0.01%,* with that accuracy maintained *indefinitely* and *continuously!*

No more replacing or recharging storage batteries! No more uncertain results because of voltage drop! To you this means no more interrupted work schedules, no more time-consuming re-runs!

The Stability of the E-6/2-5 Nobatron is accomplished electronically, with no moving parts and a minimum of tubes. Two years' rigorous testing of prototype instruments have yielded results far exceeding specifications. Write for information today.

SPECIFICATIONS

Input voltage range	95-130VAC, 1o, 50-60 cycles
Output	
#1 for lamp	6VDC adjustable ±10% at 5 amperes
#2 for filament	6VDC at 100 Ma.
#3 for bias	2VDC adjustable ±10% at 100 Ma.
Filtering	
#1	1% max.
#2 & 3	0.05% max.
Regulation accuracy	±0.01% against line changes
Time constant	0.1 seconds under most severe line changes
Size:	17 x 12¼ x 17 self contained 19 x 12¼ panel for relay rack mounting
Weight:	Approximately 90 pounds
Meters:	No meters are provided due to the extreme regulation accuracy involved.

SORENSEN

SORENSEN AND COMPANY • 375 FAIRFIELD AVE., STAMFORD, CONN.

For more information circle **74** on inquiry card.

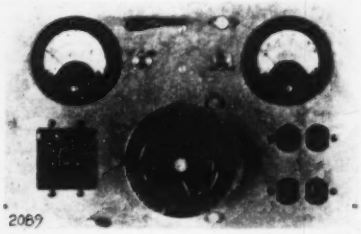
NEW INSTRUMENTS

ulation. Relay-rack or table models. 0 to 600 v.dc. vernier calibrated to 0.25 percent (or better where required). Current ratings presently available, 0-600 ma. or 0-1,000 ma.; regulation 0.05 percent (or better where required).—*Electronic Measurements Company, Inc., Lewis St. and Maple Ave., Eatontown, N. J.*

For more information circle **355** on inquiry card.

Regulated Power Supply

New adjustable a-c. regulated power supply is available in several models for output requirements from a



minimum of 0.1 amp. to a maximum of 100 amps. Output voltages variable by a front panel control.—*Summit Electronics, Inc., 7 Industrial Place, Summit, N. J.*

For more information circle **356** on inquiry card.

AMPLIFIERS

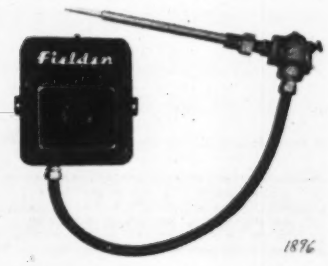
Multi-channel Amplifier

New "Type DC-1B" multi-channel d-c. amplifier is available in unitized systems containing from 1 to 12 amplifier channels and a matched power supply; can be used for driving galvanometers in a recording oscillograph, for preamplification in multiple CRT installations or multi-channel tape recording, etc. Frequency response flat within 1 percent from 0 to 10 kc. and down approx. 3 db at 100 kc. Input impedance 100,000 ohms and internal impedance 1,000 ohms (other values of latter on special order). Noise level 50 microvolts or less and d-c. drift 50 microvolts per hour or less (after warmup), both figures being referred to input. Gain adjustable from maximum of 10,000 to minimum of 10, by separate input and feedback attenuators, each adjustable from 0 to 30 db in discrete steps. A 100-0-100 indicator and precision VDR are used for balance and calibration of input devices; a push-button-actuated circuit raises indicator sensitivity as balance is approached. Entire system may be either a bench or rack-mounted instrument. All power and input-output connectors located at rear.—*Wm. Miller Instruments, Inc., 325 North Halstead, Pasadena, Calif.*

For more information circle **357** on inquiry card.

D-c. Amplifiers

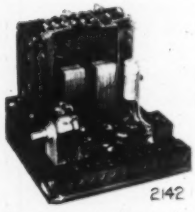
New "Series 80" d-c. amplifiers are of null-balance type; incorporate a high-gain feedback loop; are said to have exceptional long-term and short-term stability; are suitable for lab-



oratory and industrial use, as thermocouple amplifiers, as constant-current sources in conjunction with standard cells, etc. They have extremely high input impedance when used with voltage inputs. Where input is current, input impedance is negligible. Ranges extend from 5 microvolts and 20 microamps. full-scale, and output is 5 milliamps. full-scale.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth Street, Philadelphia 33, Pa.*

For more information circle **358** on inquiry card.

Magnetic Amplifier



New single-stage magnetic amplifier for educational and experimental purposes comes with full working instructions; is so designed that its basic principles can be easily investigated. All important measuring points are easily accessible and circuit can be traced by following color-coded connections. Positive feedback ampere turns are 100 percent with an additional 5 percent which may be connected additively or subtractively, giving 95 to 105 percent feedback. Bias may be varied. A capacitor prevents rectification of induced harmonic currents circulating in bias winding. Supply voltage: 20 volts @ 50 cps. Output power: 2.7 watts in 30-ohm load. Power amplification: 40,000 with 100 percent self-excitation in 30-ohm load.—*Electro Methods Ltd., Caxton Way, Stevenage, Herts., England.*

For more information circle **359** on inquiry card.

Magnetic Amplifiers

New "Model M-21 Low-Level Magnetic Amplifier," for current measurement from high-impedance sources, contains only one half-wave rectifier. An input current from 0 to 50 ua. d.c. produces a linear output from 0 to 10 ma d.c. into 100-ohm load. ★ New "Model M-22 Low-Level Magnetic Amplifier," of self-balancing type, containing only one full-wave bridge rectifier, is suitable for voltage measurement: thermocouples, strain gages, etc. Dynamic impedance of control loop is as high as 100 to 500 times actual d-c. resistance: energy taken

SHOW TEMPERATURE AT THE CONTROL PANEL

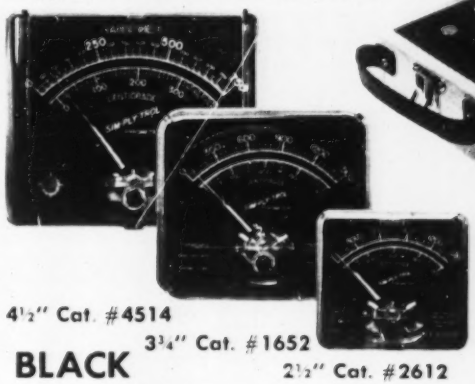
4½" Cat. #4511
3¾" Cat. #1654
2½" Cat. #2613

WHITE FACE

WARN OF TROUBLE WHEN IT STARTS — USE SIMPLYTROL INDICATING PYROMETERS.

Medium resistance pyrometers (4 ohms per millivolt). Automatic, bimetal cold junction correction. Compensated for copper error. With adjusting resistor to take thermocouples up to external resistance shown in table. When specified will be adjusted for mounting in steel panel. Accuracy 2%.

Contact pyrometers have same size and appearance but include contacts, adjustable to close at any place on the scale arc. Ask for Bulletin G-5.



4½" Cat. #4514
3¾" Cat. #1652
2½" Cat. #2612

BLACK FACE

PORTABLES

Any of these pyrometers can be supplied in the Model B carrying case or in the Model C bench stand. Ask for Bulletin G-3.

Temperature Range Degrees		Int. Res.	Ext. Res.	Thermocouple	2½ inch Size 261 Cat. No.	Price	3¾ inch Size 351 Cat. No.	Price	4½ inch Size 451 Cat. No.	Price
0—3000° F	0—1650° C	70	10	Pt13%Rh	2618	$19.90	1658	$22.75	4518	$30.25
0—2500	0—1370	212	10	C/A	2611	18.40	1651	21.25	4511	28.75
0—2000	0—1100	172	10	C/A	2616	18.40	1656	21.25	4516	28.75
0—1500	0— 800	179	10	I/C	2612	18.40	1652	21.25	4512	28.75
0—1000	0— 500	112	10	I/C	2615	19.50	1655	21.80	4515	29.90
0— 750	0— 400	81	10	I/C	2614	19.50	1654	22.45	4514	31.05
0— 500	0— 260	52	8	I/C	2613	20.10	1653	23.00	4513	32.20
— 75 to 225	— 60 to 110	30	5	I/C	2617	23.00	1657	26.50	4517	35.65
—200 to 100	—130 to 40	30	5	C/C	2619	29.00	1659	32.50	4519	41.65

Several intermediate ranges not listed.

Thermocouples:—(not included). Chromel-alumel (C/A) 14 ga. insulated 5′ leads $4.00. Iron-constantan (I/C) or copper-constantan (C/C) 20 ga. insulated 5′ leads $2.90.

ASSEMBLY PRODUCTS, INC., P. O. BOX 191, CHAGRIN FALLS, 10, OHIO

For more information circle **75** on inquiry card.

VHF

. . . Very High Frequencies

RADIO INTERFERENCE and FIELD INTENSITY* measuring equipment

Stoddart NM-30A • 20mc to 400mc

Commercial Equivalent of AN/URM-47

PRINTED CIRCUITRY . . . Modern printed circuits offer many advantages over conventional wiring, lighter weight, more compact units and freedom from many of the troubles normally encountered in conventionally-wired electronic equipment. Vibration becomes even less of a problem with printed circuits, adding to the many portable features already available with Stoddart equipment.

ADVANCED DESIGN . . . Specialized engineering and modern production techniques have produced one of the most advanced instruments for the accurate measurement, analysis and interpretation of radiated and conducted radio-frequency signals and interference ever manufactured. Designed to laboratory standards, rugged, and with matchless performance, the versatile NM-30A is an outstanding example of modern instrumentation. Its frequency range includes FM and TV bands.

SMALLER SIZE . . . A wider frequency range and higher standard of performance is incorporated into an equipment whose size is one-third that of any similar equipment ever manufactured.

SENSITIVITY . . . Sensitivity ranges from one to ten microvolts-per-meter, depending upon frequency and antenna in use.

APPLICATIONS . . . Field intensity surveys, antenna radiation pattern studies, interference location and measurement for checking radiation from virtually any mechanical or electrical device capable of generating or radiating radio-frequency signals or interference.

Stoddart RI-FI* Meters cover the frequency range 14kc to 1000mc

VLF
NM-10A, 14kc to 250kc
Commercial Equivalent of AN/URM-6B. Very low frequencies.

HF NM-20B, 150kc to 25mc
Commercial Equivalent of AN/PRM-1A. Self-contained batteries. A.C. supply optional. Includes standard broadcast band, radio range, WWV, and communications frequencies. Has BFO.

UHF
NM-50A, 375mc to 1000mc
Commercial Equivalent of AN/URM-17. Frequency range includes Citizens band and UHF color TV band.

STODDART AIRCRAFT RADIO Co., Inc.

6644-D Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

For more information circle **76** on inquiry card.

NEW INSTRUMENTS

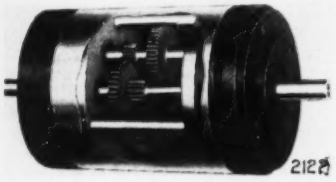
from signal source is extremely low. Input voltage from 0 to 10 mv. d.c. produces a linear output from 0 to 10 ma. d.c. into 1000-ohm load. D.c. voltage gain up to 5000 in 100,000-ohm load. ★ For both models: Zero drift for 10 hours about 10^{-12} watts; time constant 1 cycle. Dimensions 2x2¼x-2½ in.; sealed plug-in type (rectifier outside of can).—*Magnetic Controls, Inc., 119 W. 63rd St., New York 23, N. Y.*

For more information circle **360** on inquiry card.

MECHANICAL COMPONENTS

Miniature Speed Reducers

New series of precision miniature speed reducers feature backlash less than 0.5 deg.; comprise two basic

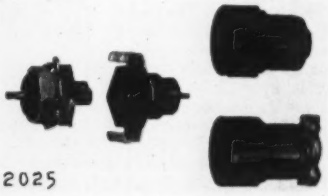


units, "1062" and "1687," 1.062 and 1.687 in. diam. respectively by 1.656 and 1.859 in. long exclusive of shaft length which can be specified. Ratios from 12.5 to 10,000:1. "Series 1062" is designed for output torque loads up to 25 in.-oz.; "1687" up to 100 in.-oz. Both feature A.B.E.C. Class 5 ball bearings throughout. Sleeve bearings for gear clusters may be specified where utmost precision is not required. —*Bowmar Instrument Corp., 2415 Pennsylvania St., Fort Wayne, Ind.*

For more information circle **361** on inquiry card.

Cable and Panel Connector

New "Series C-20" high-voltage miniature single-contact cable and panel connector is suitable as a feed-



through with hood as grip for disconnecting both parts. Accidental disconnection is prevented.—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

For more information circle **362** on inquiry card.

Heavy-duty Terminal

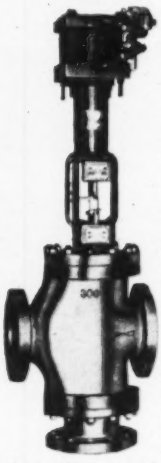
New "Ampli-Bond" insulated terminal for users of heavy duty wire features positive bond of insulation to terminal sleeve, insures uniform insulation thickness under confined crimping pressures, transmits this pressure evenly to center of crimp area. Separate metallic ring grips wire insulation, prevents exposure of

conductor during sharp bends. Vinyl insulation withstands 6000 volts (four times military specs).—*Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa.*

For more information circle **363** on inquiry card.

VALVES

High-speed Diversion or Proportioning Valve

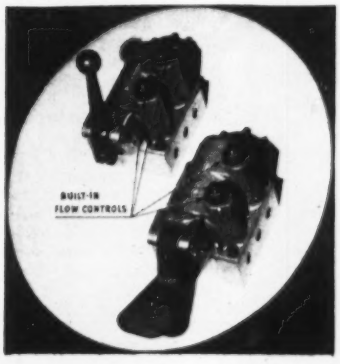


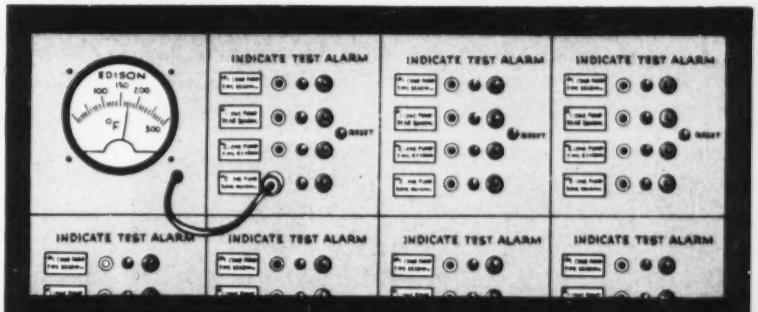
New three-way cylinder-operated valve combines high travel with speed on both pressure stroke and spring return. When used as an emergency diversion valve with less than 100 psi. on cylinder, full travel with tight shut-off is accomplished in 0.5 sec. On spring return, same speed can be achieved. Use of spring return, rather than double-acting cylinders, permits valve to fail in either open or closed position as required for safety. Valve is designed also for use of auxiliary equipment such as explosion-proof signal contacts or solenoid pilots which feed or bleed for on-off operation through pipe rather than small instrument tubing. New valve is also available with V-ports and valve positioners for throttling applications. Sizes from ½-in. to 10-in. with either Teflon or greased lubricant stuffing boxes.—*Kieley & Mueller, Inc., 150 Genung St., Middletown, N. Y.*

For more information circle **364** on inquiry card.

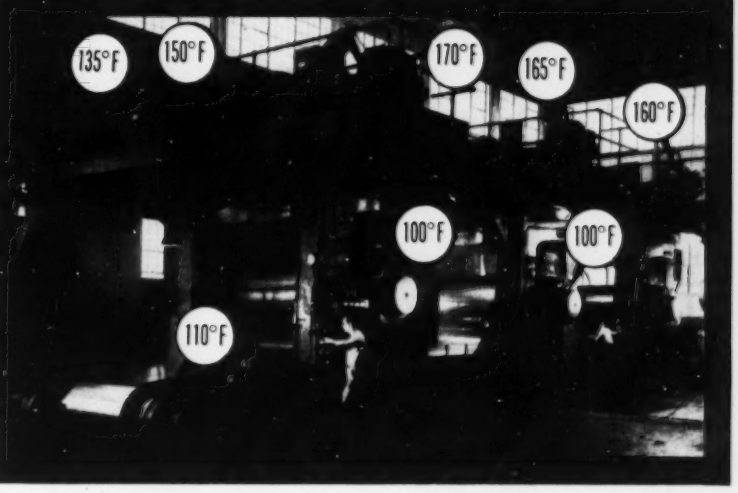
Four-way Valve

New hand-and-foot operated four-way valve, with built-in full-capacity flow-controls of Venturi type, is designed for control of double acting air or hydraulic cylinders to 150 psi. Basic valve is also available for remote pilot operation, cam, single or





Edison's NEW Omniguard Pinpoints "Hot" Points



OMNIGUARD – simplest and most flexible temperature monitoring system yet devised – safeguards industry. Wherever power is generated . . . wherever chemical processes are in motion . . . wherever machinery is in operation, **OMNIGUARD**, with unique "building-block" construction, pinpoints the vital "hot" points reached by Edison resistance temperature detectors.

Designed and developed at the world-famous Edison Laboratory, only **OMNIGUARD** has these new, *exclusive* features:

▶ **Constant protection** – All points are "on-guard" at all times. Instant alarm the moment critical temperature is reached–*without scanning mechanisms* or codes.

▶ **Individual alarm point adjustment** – Each point has own alarm setting – can be adjusted on the spot without special tools.

▶ **Installation adaptability**–Group the units close to protected equipment – or in control room with minimum wiring and at lowest installation cost.

▶ **Equipment flexibility**– Basic monitor units handle as few as four points. More points can be added at any time. One indicator serves multiple points.

▶ **Design simplicity** – System monitors without moving parts–nothing to "wear" out. No electronic tubes or complex circuits.

Write us, won't you, for more specific information on *your* heat control problem?

Thomas A Edison

A GREAT NAME CONTINUES GREAT NEW ACHIEVEMENTS

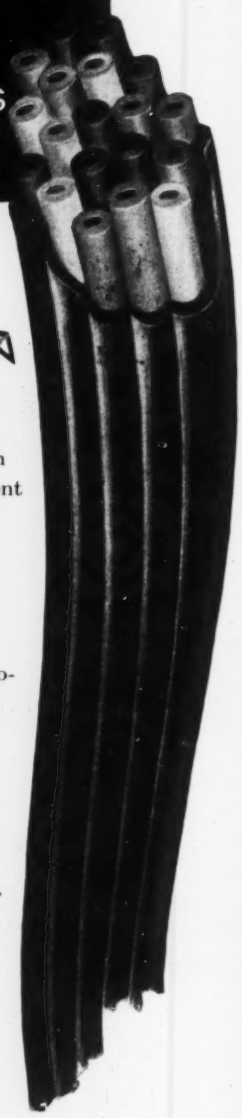
Thomas A. Edison, Inc.

INSTRUMENT DIVISION • 24 LAKESIDE AVENUE • WEST ORANGE, NEW JERSEY

For more information circle **77** on inquiry card.

DEKORON PRODUCTS CUT INSTRUMENT TUBING COSTS

EASY-TO-INSTALL INSTRUMENT LINE HARNESS



DEKORON Poly-Cor is a new concept in instrument tubing — a lightweight instrument line harness that can be strung as easily as electric wiring.

Poly-Cor is composed of color-coded polyethylene tubes over which is extruded a thick vinyl sheath. This construction means instrument lines are completely corrosion proof. Their natural resiliency resists physical damage. Harness composed of 4, 7, 10, 14 or 19 (*illustrated*) individual lines is available.

Initial cost . . . installation . . . corrosion resistance . . . maintenance — *no tubing can compare with patented Dekoron Poly-Cor.* Request Bulletin L-6506.

Use Dekoron E-Z Tube Fittings. Specifically designed for use with Poly-Cor or with single-line plastic Dekoron "P" Tubing.

Dekoron® *products*

quality research service

SAMUEL MOORE & COMPANY • MANTUA, OHIO

DEKORON PRODUCTS DIVISION

For more information circle **78** on inquiry card.

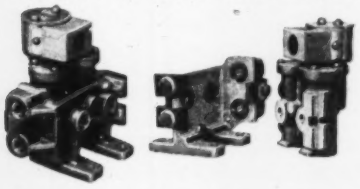
NEW INSTRUMENTS

double solenoid together with time-delay features. Sizes: ¼-in., ⅜-in., ½-in. and ¾-in.—*Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.*

For more information circle **365** on inquiry card.

Sub-base-mounted Valves

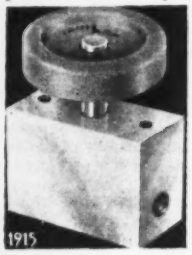
New sub-base-mounted "Crescent" pilot-operated solenoid-controlled four-way valves can be replaced in seconds. By loosening three holding clamp bolts, entire valve body can be removed and replaced by a new one. Sub-base remains undisturbed as a permanent part of piping. Valves are for air, light oil and water, pressures to 150 psi.—*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*



For more information circle **366** on inquiry card.

Manual Shut-off Valves

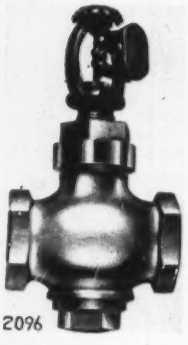
New "900 Series Circle Seal" manual shut-off valve offer positive leak-proof shut-off by a resilient O-ring, which is withdrawn automatically from fluid stream as soon as valve begins to open. Throttling is then accomplished by a conical metal plug which varies orifice area. Rated at 0-3000 psi., hydraulic or pneumatic service.—*James-Pond-Clark, 2181 East Foothill Blvd., Pasadena 8, California.*



For more information circle **367** on inquiry card.

Safety Fuel Valve

New "Valco Safety Valve" automatic temperature-actuated valve shuts off supply of flammable material during a fire. For use in gasoline, fuel oil, natural gas, jet fuel, ether, and other flammable-materials lines, it is normally held in open position by a standard sprinkler head. At specified temperature, head opens and releases a strong stainless steel spring which snaps valve closed. Valve is packless: it uses a metal bellows seal which permits rapid inspection and change of heads without leakage. Sizes from ½-in. to 6 in.—*Valco, Inc., 1410 West St., Cincinnati, Ohio.*



For more information circle **368** on inquiry card.

Panel-mounted Needle Valve

New "PM Series" panel-mounted needle valve can be installed in seconds: loosened packing nut and first holding nut are removed; threaded stem guide slipped through panel opening; first packing nut replaced and adjusted in relation to second packing nut, firmly mounting valve in panel; assembly is completed with addition of packing nut and valve handle. New valves are designed for 10,000 psi., water, oil, or gas. Bodies are marked in accordance with M.S.S. regulations: size, material, service symbol, and maximum pressure.—*Jas. P. Marsh Corp., Skokie, Illinois.*

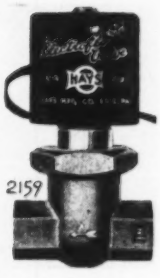
For more information circle **369** on inquiry card.

Solenoid Valves

New stainless-steel solenoid direct-lift valves in ⅛-in. and ¼-in. pipe sizes have pressure ratings of 5000 psi. to 150 F. and 2500 psi. to 400 F.; orifice diameters from 1/16 in. to 3/16 in. depending on pressure requirements and coils. Higher pressures use double-wound coils: an extremely strong winding for initial pull-off and a normal winding for holding.—*Atkomatic Valve Co., 545 Abbott St., Indianapolis, Ind.*

For more information circle **370** on inquiry card.

Solenoid Valve



New "Electro-flo Valve" provides automatic on-and-off control of flow (water or air); is piston-type, pilot-action, solenoid-operated; has "anti-water hammer" feature; is built of non-corrosive parts; is packless. Now available in ⅜-in., ¾-in., and 1¼-in. pipe sizes.—*Industrial Sales Div., Hays Mfg. Co., 814 12th St., Erie, Penna.*

For more information circle **371** on inquiry card.

Solenoid-controlled Pilot-operated Valves

New solenoid-commanded four-way five-port valves, for low-pressure systems, utilize pilot pressure (equal to operating line pressure) to shift valve spool, thus permitting use of small continuous-duty solenoid directional valve instead of large directly-connected solenoid actuators. Same valve may be used as one three-way, two three-way, or two-two-way combinations, on air, gas, water or oil, at

If time is an element in the operation of your product or process, be sure to call in your factory-trained HAYDON Sales Engineer. HAYDON Timing Motors utilize time, control time, master time . . . precisely, quietly . . . bettering performance and opening new horizons to product and process use.*

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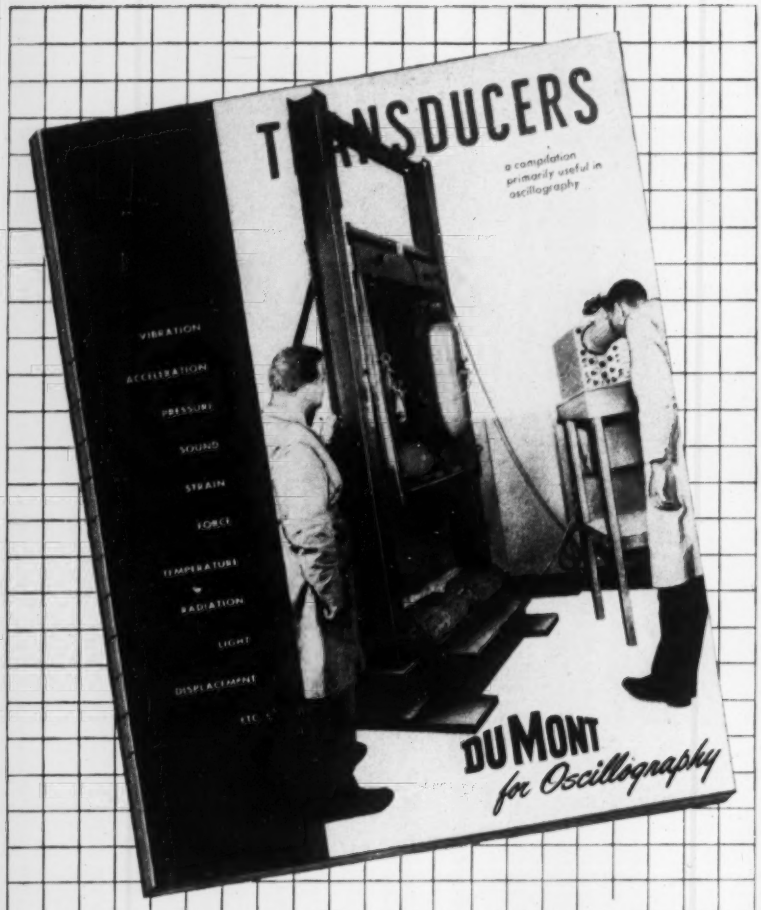
For more information circle **79** on inquiry card.



the Key to.....

OSCILLOGRAPHIC INSTRUMENTATION

In those applications where electrical potentials do not exist, fullest exploitation of the many advantages of cathode-ray oscillography depends upon the selection of the proper transducer.

As a service to users of cathode-ray oscillographs, Du Mont has compiled the most complete listing of transducers ever offered in a single volume.

Over 650 transducers and more than 150 accessories are classified as to application, general characteristics and manufacturers' name and address—164 pages—serving as your key to oscillographic instrumentation.

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For more information circle **80** on inquiry card.

NEW INSTRUMENTS

pressures not exceeding 200 psi. Various spool and spring-centering or spring-offset combinations are available with single solenoid, double solenoid, pilot pressure reset, etc.—*Modernair Corp., 400 Preda St., San Leandro, Calif.*

For more information circle **372** on inquiry card.

AVIATION & MARINE

Yaw-angle Pickup

New "TR500 Relative Wind Transducer (Weathercocking Design)" is used to indicate local angle of attack or yaw of an aircraft. It derives its power from air forces acting on its protruding vane and produces an electrical output proportional to measured angle, to better than 0.1 percent accuracy. Unit weighs 1.5 lbs. including cable and connector; meets all applicable MIL specs.—*Servomechanisms, Inc., El Segundo Div., 316 Washington St., El Segundo, Calif.*

For more information circle **373** on inquiry card.

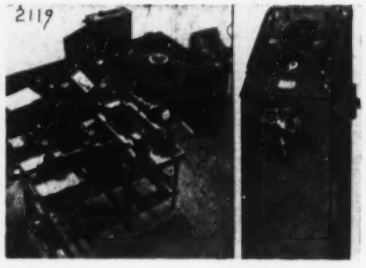
Aircraft Attitude Indicator

New remote-reference "Model 978-K Pictorial Vertical Gyro Attitude Indicator" simplifies problems of instrument flight in high-performance jet aircraft; displays a miniature reference airplane against a moving background sphere painted to simulate sky, horizon and earth. Angles of climb, dive and bank can be read to within one degree from scales on face of instrument.—*Lear, Inc., 110 Ionia Ave. NW, Grand Rapids 2, Mich.*

For more information circle **374** on inquiry card.

Ship-steering Mechanism

New "Automatic Ship's Steering Mechanism" is said to be the first fully automatic device for steering



large ships accurately and compensating for wind and current. A 0.1-microwatt signal from gyro produces a 5,000 lb.-in. torque on rudder. Illustration shows steering stand and rotary hydraulic actuator.—*Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson 3, N. J.*

For more information circle **375** on inquiry card.

TAPE RECORDING

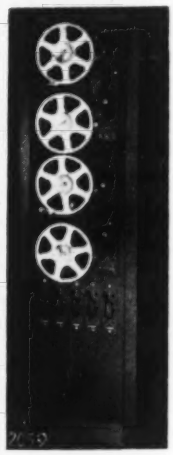
LP Battery-operated Portable Tape Recorder

New "Magnemite 610-A" battery-powered portable (12-lb.) tape recorder with spring-wound motor operates at a tape speed of 15/16 ips.;

frequency response of 300 to 2,500 cps.; designed for all types of field recording. Low flutter (0.25 percent) over full winding cycle of 30 minutes is achieved by triply-compensated flyball governor. Dual track recording provides uninterrupted playing time of 2 hours per track, total 4 hours on a 5-in. reel: 600 ft. of standard ¼-in. tape.—*Amplifier Corp. of America* 398 *Broadway, New York* 13, *N. Y.*

For more information circle **376** on inquiry card.

Four-channel Single-tape Sound and U-s. Recorder



New four-channel single-tape recorder (adaptation of maker's similar unit of which 74 are in 24-hour use by Civil Aeronautics Administration) is applicable wherever simultaneous recording is desired of two to four intelligence signals. Example: on-the-spot account of a surgical operation by up to four surgeons and attendants using lip microphones. Also inter-communications between police, fire and similar bodies. In engineering and research it will record and reproduce at over 250,000 cps.; useful in experimental planes, submarines, land vehicles, meterology, etc.—*Magnecord, Inc.*, 225 *W. Ohio St., Chicago* 10, *Ill.*

For more information circle **377** on inquiry card.

Magnetic Tape Splicer

New "TS-4" cutter-splicer for magnetic recording tape cuts two rounded indentations in tape splice, leaving

edges of tape, which contact parts of recorder, entirely free of adhesive. May be removed from its base and mounted on any tape recorder.—*Tale Industries Corp.*, 82-09 251*st St.*, *Bellerose* 26, *N. Y.*

For more information circle **378** on inquiry card.

COMMUNICATION

High-output 'Phone Receiver

New "Type RA-1H High Output Telephone Receiver" lessens problems due to weak signals from receivers of telephone handsets. Example, in conference calls, drastic reduction in response level when incoming signal is divided between two or more

For lighter, more compact, Servo Systems

THE NEW

KEARFOTT

PENNY SIZE

SYNCHROS

Accurate . . . Rugged Dependable

PERFORMANCE DATA

	TRANSMITTER	CONTROL TRANSFORMER
PRIMARY EXCITATION	26 VOLTS 400 CYCLES	11.8 VOLTS 400 CYCLES
INPUT CURRENT	95 Ma	137 Ma
INPUT IMPEDANCE	274/75° Ohms	82/68° Ohms
OUTPUT SECONDARY	11.8 VOLTS	23.5 VOLTS
RESIDUAL (NULL) VOLTAGE	40 Mv RMS 20 Mv Fund	40 Mv RMS 20 Mv fund
SENSITIVITY	200 Mv/Degree	400 Mv/Degree
WEIGHT	1.75 Oz.	1.75 Oz.
MAXIMUM ERROR from EZ	10 Minutes	10 Minutes

Kearfott now offers from production the smallest, accurate line of Synchros available. These Transmitters and Control Transformers, Resolvers and Differentials, conform to Navy BuOrd. Size 8. Integrally cast stator and stainless steel housing assemblies permit straight through bores, eliminating the fundamental errors of eccentricity; providing ruggedness and environmental resistance to these components.

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For more information circle **81** on inquiry card.

When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.

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For more information circle **82** on inquiry card.

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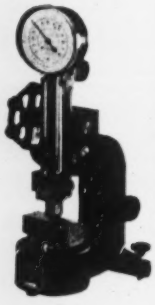

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For more information circle **83** on inquiry card.

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For more information circle **84** on inquiry card.

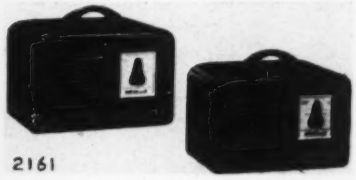
NEW INSTRUMENTS

'phones. "RA-1H Receiver" is said to have "approximately four times the acoustical energy of the commonly used Western Electric HA-1 Receiver or other similar units." Output is approx. 5 db higher over normal speech response range than "HA-1" and is about equal to output of "U-1 Receiver" used in new WE "500 Series Handset." "RA-1H" is dimensionally equivalent to "HA-1" and can therefore be used as a direct replacement.—*Roanwell Corp., 662 Pacific St., Brooklyn 17, N. Y.*

For more information circle **379** on inquiry card.

Wireless Intercom

New industrial model of "Hirshcall" portable wireless intercom combines services of watchman (on constant



transmit) and messenger (on talk-listen); plugs into any electrical outlet and requires no wiring or installation; transmits sound clearly over a radius of several miles; is listed by Underwriters' Laboratories as safe against shock or fire hazard.—*S. A. Hirsh Mfg. Co., 8051 Central Park Ave., Skokie, Ill.*

For more information circle **380** on inquiry card.

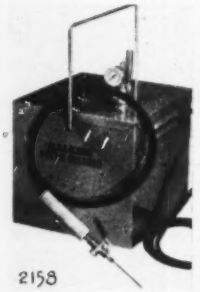
MISCELLANEOUS

Small-parts Cleaner

New "Jet-Action Small Parts Cleaner" is designed for quick attachment to any air hose. Eight air jets in 6½-gal. agitator unit set up turbulence that causes solvent to penetrate into cracks or crevices in parts being cleaned and precipitate scale and sediment to sump. Specially-designed "Jetisoil" solvent assures maximum results with minimum loss through evaporation; emits no offensive odors. —*Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1, Calif.*

For more information circle **381** on inquiry card.

Portable Steam Cleaner



New lightweight (50-lb.) electrically-heated pressurized-steam cleaner degreases, removes contamination; without disassembly, from otherwise inaccessible parts; is safe and simple to operate: fill with water, plug in. Thermostatically controlled. Manufactured in accordance with ASME Miniature Boiler Code.—*Halkirk Co., 2004 Strand, Manhattan Beach, Calif.*

For more information circle **382** on inquiry card.

Liquid-level Indicator

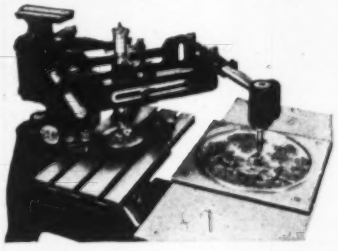
New "Sonic Liquid Level Indicator" permits operator at control station to read level of liquid in open or closed

tanks within a 2,000 foot radius of set to an accuracy of within 0.001 foot.—*Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson 3, N. J.*

For more information circle **383** on inquiry card.

Three-dimensional Engraver

New "Preis-Panto Model 3D-5 Engraver" is a three-dimensional engraving machine that will engrave metals, plastics, wood, etc., in ratios

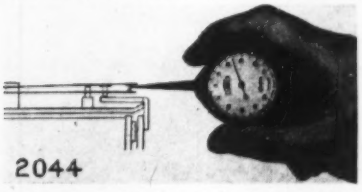


from 1.7:1 to 7:1; also enlargements in reverse of these ratios. Limits: 4½-in. diam. circle at 2:1 ratio and 1⅜-in. circle at 7:1 ratio; four spindle speeds. Furnished complete with motor, all standard attachments, and full operating instructions.—*H. P. Preis Engraving Machine Co., 156 Industrial Branch, Hillside, N. J.*

For more information circle **384** on inquiry card.

Torque Gage

New "Correx Torque Gauge," designed for measurements on relays, switches, breakers, contact brushes,



springs, etc., is made in Switzerland by firm that originated this type of instrument. Ten measuring ranges. Feature is maximum-registering slide. —*Victor George Herman, 311 W. 97th St., New York 25, N. Y.*

For more information circle **385** on inquiry card.

Frequency Regulator and Inverter Assembly

New "Model M-1087 Precision Frequency Regulator and Inverter Assembly" is an integrating type control unit for high-precision rate gyros, motors and servos requiring accurate frequency regulation; is adaptable to inverters of different sizes, ratings,

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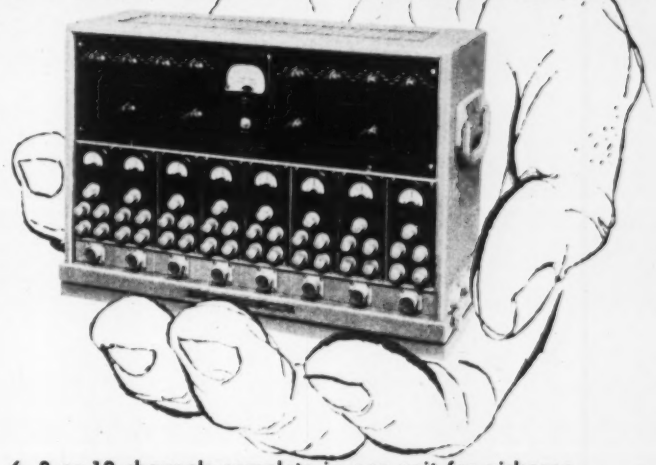
The World's Finest Dynamic Strain Analysis Equipment...

All the features you have ever dreamed of conveniently packed in one small unit...

THE NEW HATHAWAY MRC-21



6, 8 or 12 channels complete in one unit for airborne, mobile or laboratory applications.

Carrier-type amplifiers (response 0-1500 cps) . . . or

Wide-band amplifiers (response 2-6000 cps).

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1. Interchangeable amplifiers, carrier or wide-band covering range of **0-6000 cps**
2. Unbelievable insensitivity to shock or vibration
3. The most convenient arrangement of controls you ever saw
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6. Automatic calibration, with different value of strain in each channel if desired, **just by pressing a button!**
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For more information circle **85** on inquiry card.

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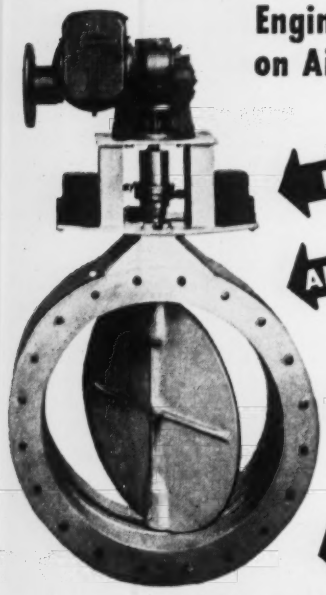

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RESISTANT Made ruggedly for all conditions of corrosion, erosion, temperatures to 2000° F., pressures to 300 p.s.i.

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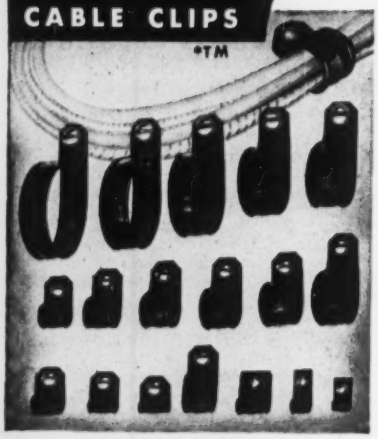
For more information circle **86** on inquiry card.

NyGrip* **CABLE CLIPS** *TM



Hold that wiring with these all Nylon cable clips

* Lightweight * Tough * Strong
* Chemically resistant
* No metal to corrode or cause short circuits
* Easy to apply * No sharp edges
* May be used from — 60° to 250° F.

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For more information circle **87** on inquiry card.

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The Acragage has always been the safe gage, the gage with the solid front and full area blow-out disc.

Catalog M-50 tells more about the safe ACRAGAGE.

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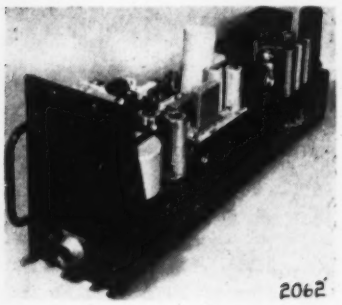
For more information circle **88** on inquiry card.

NEW INSTRUMENTS

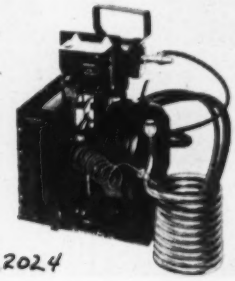


and manufacture; provides average frequency control of 400 ± 0.1 cps. and instantaneous control of 1 cps.; operates without separate power supply.—*The W. L. Maxson Corp.*, 460 *W. 34th St., New York* 1, *N. Y.*

For more information circle **386** on inquiry card.

Refrigeration System

New portable refrigeration system features "complete control to give any cooling capacity, large enough to cool

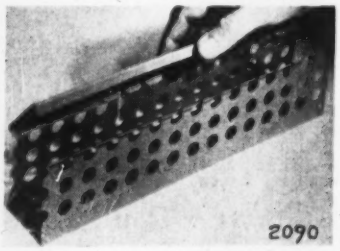


largest water bath," useful for thermometer calibration, freezing stage for microscopes, etc. Comes complete with 6-foot length of insulated tubing and a copper coil; is flexible enough for coils of user's design.—*A. Daigger & Co.*, 159 *W. Kinzie St., Chicago* 10, *Ill.*

For more information circle **387** on inquiry card.

Wiring Duct

New wiring duct designed to hold, protect, and distribute a harness, saves time and labor; is made from a

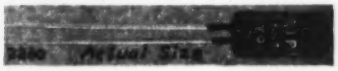


thermoplastic material. Cover snaps on and off. Clips, inserted at regular intervals, hold wires and eliminate costly lacing of harness. Will not support combustion, will not warp in dampness. Lengths up to 45 in. Easily cut with a knife. Parcel post shipments.—*Taylor Electric, Inc.*, 15460 *Dale, Detroit* 23, *Mich.*

For more information circle **388** on inquiry card.

Crystal Photocell

New "Type CL-1" photoconductive cell employs a small cadmium sulphide crystal as light sensitive element; has a sensitivity to light flux about one

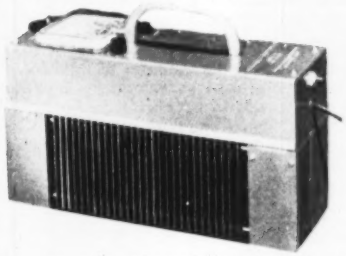


million times sensitivity of a conventional high-vacuum photoemissive tube. Median sensitivity is 100 microamperes at 100 volts at 2 foot-candles. At low light levels, its output is sufficient to operate electrostatic relays. It also has high ratio of light to dark current for a photoconductor (about 60 db at 1 foot-candle). It is not a photo-diode but conducts substantially the same with both polarities of voltage and thus can be used to modulate an alternating current. It is moisture-proof and its construction permits soldering into a circuit without special precautions.—*Clairex Corp., 50 W. 26th St., New York 10, N. Y.*

For more information circle **389** on inquiry card.

Ultraviolet Photometer

New "Model 51" u-v. photometer measures and immediately indicates concentration of certain toxic vapors in air. Principle: absorption at 2537-

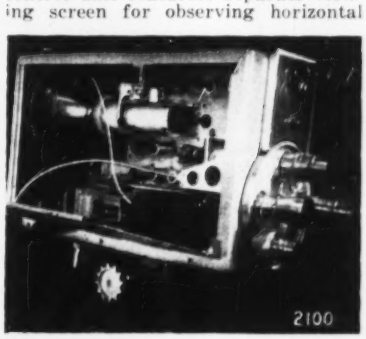


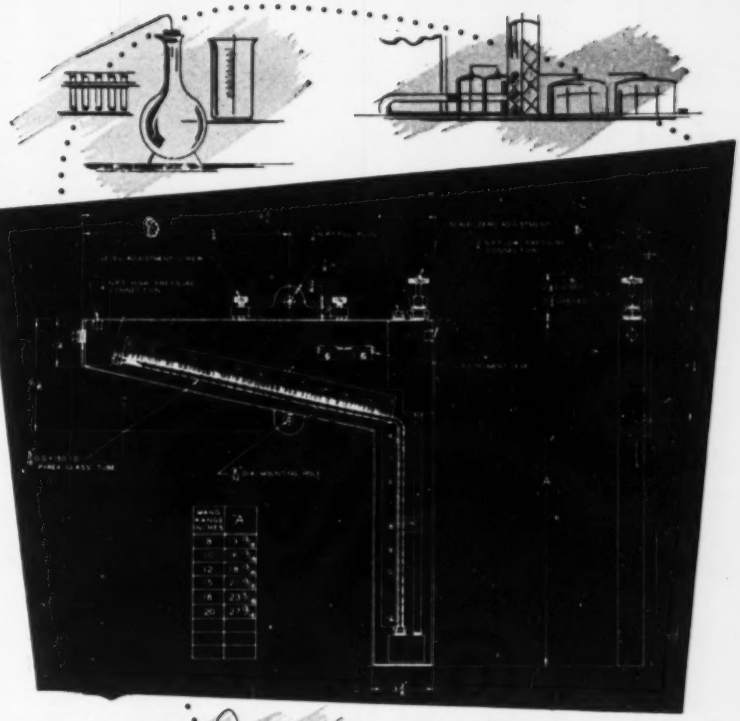
Angstrom wavelength and use of internal standard and balanced phototubes. No solutions to mix or standards to prepare: each instrument comes with a list of vapors and their standard settings. Weight 8 lbs.—*Harold Kruger Instruments, P. O. Box 164, San Gabriel, Calif.*

For more information circle **390** on inquiry card.

TV Equipment

New "Model UK-1A" photoconductive camera chain includes camera with cables, friction head and dolly, camera control monitor and synchronizing generator. Camera features: electronic viewing, 7-in. direct-view screen; all controls except mechanical focus located on illuminated control panel below viewing screen. Camera control unit features: separate viewing screen for observing horizontal





Model A-311 Manometer clearly indicates 1/100 inches water differential in the 0" to 3" water range and in 1/10 inches over the balance of the scale.

MERIAM MANOMETER ACCURACY FOR *Low Flow* INDICATION

The A-311 manometer gives pin-point readability in those critically low flow range with characteristic Meriam Manometer accuracy. Reading of the first three inches is on an expanded scale. Over the balance of the scale, indication is in inches and tenths.

As in all Meriam instruments, you will find immediate and long-range economy in the precision of the Meriam Model A-311. With the pride of craftsmanship of many years, we continue to put our best into these dependable, highly sensitive instruments.

Talk to your *MIT Man, or write us, if you have trouble indicating pressure or flow of liquids and gases.

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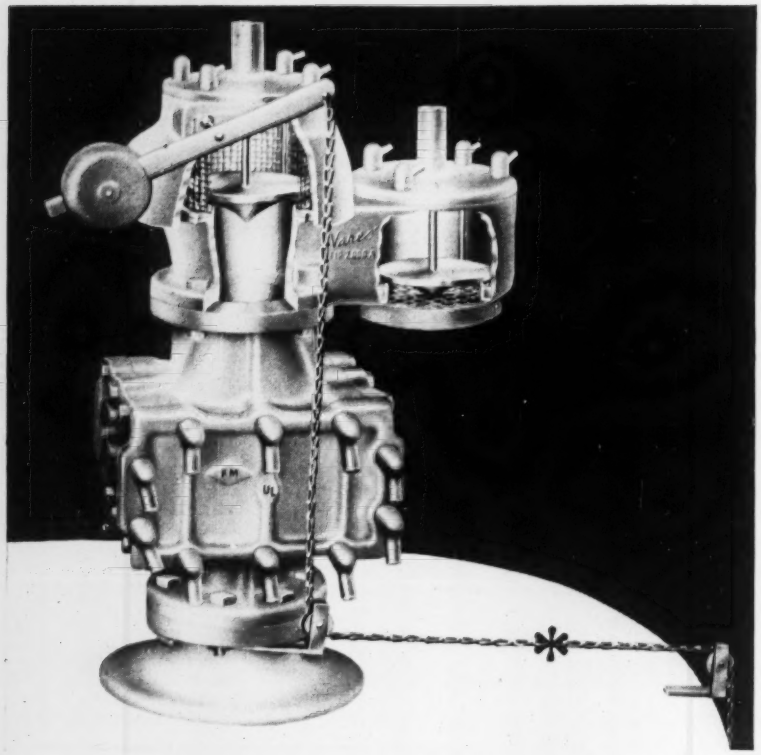
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

For more information circle **89** on inquiry card.



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Considerable profits are dissipated to the atmosphere when vent pallets warp, stick open or prevent excessive "blowdown." "VAREC" Fig. No. 5800 Conservation Vent Units are ideal equipment for venting volatile or inflammable liquid storage. They protect against dangerous over and under pressures and accidental ignition. Streamlined passages insure maximum flow. Regrindable and renewable metal pallet seats provide extra long life. Drip rings eliminate condensate collection, reducing possibility of freezing. Hyperbolic pallets, loosely guided, prevent sticking and minimize flutter. Flame Arrester unit listed by Underwriters' Laboratories and approved by Factory Mutual Laboratories. Send for free Bulletin CP-2001.

* *Remote Control Flame Snuffer Sheave Brackets, Fig. 130 are optional at extra cost. This assembly is preferable where vent unit is set back from edge of tank.*

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For more information circle **90** on inquiry card.

NEW INSTRUMENTS

and vertical wave-forms; all controls marked and arranged for convenient operation.—*Electronics Div., Willys Motors, Inc., Toledo 1, Ohio.*

For more information circle **391** on inquiry card.

Battery Charger

New "Bulletin 2038" battery charger for 6, 12, 24 and 32 v.dc. is available in designs for input alternating voltages from 120 to 600, each charger being capable of handling two or three input voltages. Charging rate 0.05 to 2 amps. continuously adjustable and indicated. Diagram on panel indicates connections and numbered terminals simplify connecting.—*Automatic Switch Co., 385-T Lakeside Ave., Orange, N. J.*

For more information circle **392** on inquiry card.

Mileage Counter

New "PeKa Driveless Hubodometer" for trailers, etc., operates without any outside driving parts, is completely sealed, is attached easily to any hub cap. Regardless of position of wheel, mechanism remains in proper reading position, registers backward and forward movement.—*Engler Instrument Co., 250 Culver Ave., Jersey City 5, N. J.*

For more information circle **393** on inquiry card.

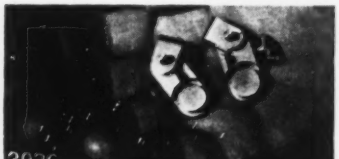
Dry-charge Batteries

New type of dry-charge electric storage battery, first of its kind to be sold in U.S., retains its initial charge "over much longer periods of time than ever before possible," particularly under adverse temperature and moisture conditions. This may largely obviate need for charging equipment which must now be on hand in military installations, etc.—*Gould-National Batteries, Inc., St. Paul, Minn.*

For more information circle **394** on inquiry card.

Wire Grips for Testers

New gripping fixtures for fine-gage wire, thread, etc., prevent full tensile stress from being brought to bear on filaments at clamping points;



only after they have been passed two or more times around self-aligning drums, thus assuring trustworthy tests. Fixtures are machined from hardened aluminum, and drums operate on free-swinging pivots so that a true vertical pull is exerted.—*W. C. Dillon & Co., Inc., P. O. Box 3008, Van Nuys, Calif.*

For more information circle **395** on inquiry card.

Events...

June 20-25

"Atoms for Peace" Exposition in conjunction with Nuclear Engineering Congress at the University of Michigan, Ann Arbor, Mich. Sponsored by Nuclear Engineering Div., AICE. For information contact C. M. Sliepcevich, Chairman, 3030 Rackham Bldg., Ann Arbor, Mich.

June 21-25

X-Ray Diffraction School, co-sponsored by University of California and General Electric Co., at Berkeley, Calif.

July 6-10

Joint Commission on Electron Microscopy of International Council of Scientific Unions. For information write F. W. Cuckow, Secretary General of Commission, Chester Beatty Institute, Royal Cancer Hospital, Fulham Road, London, S. W. 3, England.

July 8-12

Convention on Industrial Electronics, Christ Church, University of Oxford, England. For information write British Institution of Radio Engineers, 9 Bedford Square, London, W.C.1, England.

July 12-23

Boston College course in Modern Industrial Spectroscopy on the Campus. For information write James J. Devlin, S. J., Physics Department, Boston College, Chestnut Hill 67, Boston, Mass.

August 2-13

Summer Session on Metallurgical Applications of X-Ray Diffraction at Massachusetts Institute of Technology. For information write Summer Session Office, Rm. 7-103, M.I.T., Cambridge 39, Mass.

August 25-27

Western Electronic Show and Convention, Pan-Pacific Auditorium, Los Angeles, Calif. For information write Russ Broman, Wescon, 344 N. La Boca Ave., Los Angeles, Calif.

August 30—September 3

63rd Annual Convention & Trade Show, Conrad Hilton Hotel, Chicago, Ill. For information write Glassner & Associates, 35 E. Wacker Drive, Chicago 1, Ill.

Sept. 13-25

Instrument Society of America First International Instrument Congress and Exposition, Commercial Museum and Convention Hall, Phila. Contact Richard Rimbach, Mgr., 845 Ridge Ave., Pittsburgh 12, Pa.

September 29-30

Pittsburgh Conference on Industrial Electronics, sponsored by Professional Group on Industrial Electronics, Institute of Radio Engineers, at the Mellon Institute of Industrial Research, 4400 Fifth Ave., Pgh. 13, Pa. For information contact Dr. James Woodford, Carnegie Tech P. O., Pittsburgh 13, Pa.

November 29—December 2

First International Automation Exposition, at the Coast Artillery Armory, New York City, N. Y. For information write First International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Pa.

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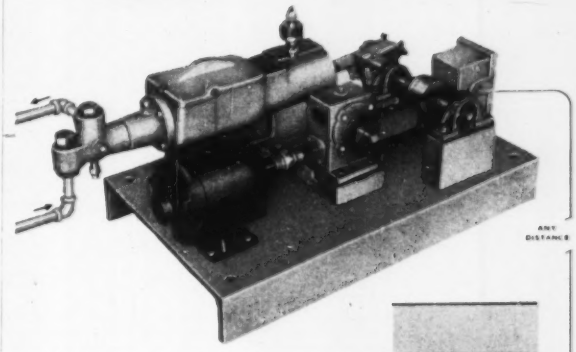
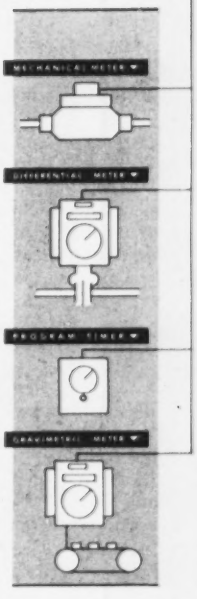




PROPORTIONEERS new Adjust-O-Feeder automatically regulates the feeding of secondary fluids in proportion to variable demand. Fluctuations in the metered variable are converted to integrator contacts which in turn regulate the number of strokes of the Adjust-O-Feeder metering pump.

This new unit meters and feeds these secondary fluids in prescribed quantities and in proportion to process requirements as determined by the sensing elements shown.

Adjust-O-Feeder metering pumps are built in a wide range of sizes, types and materials of construction to suit any field problem requiring quantities from cubic centimeters to gallons per minute and against both low and high pressures.

Ask for information and recommendations. Proportioneers, Inc., 422 Harris Avenue, Providence 1, Rhode Island.

PROPORTIONEERS

DIVISION OF B-I-F INDUSTRIES, INC.

METERS FEEDERS CONTROLS

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

For more information circle **91** on inquiry card.

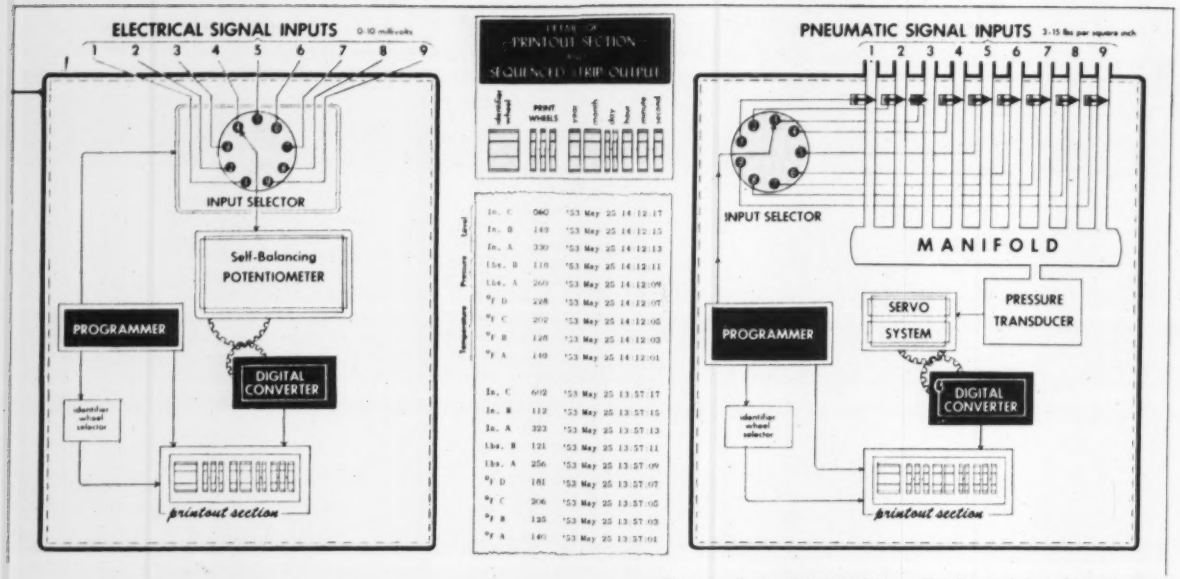


Fig. 1. Sequential multipoint digital readout of analog-type electric signals (left) and pneumatic signals (right).

Automation Via DIGITAL CONVERSION

AUTOMATIC PLANTS, to be economically feasible, will have to produce larger quantities of higher quality products than existing semi-automatic plants. The plants will be controlled as a whole, rather than as a series of independently controlled unit operations and processes. All sensing elements in the plant will be fed into one central "brain" and the instantaneous analysis of all this data will be fed back in the form of a command to appropriate control elements in the plant. On-off, proportional, reset, and rate controllers may be supplemented with an infinite number of control responses, all instantaneously available from the computer. "Digital conversion" may make all this, and more, possible with existing instrumentation systems.

The Digital Converter

A digital converter* is a device that converts an analog-type signal, such as a shaft position, to a number. There are several ways to do this. One way is to convert an angular displacement to a linear displacement by a series of cams or steps. Feelers come in during "readout" to feel the position of the steps, and to activate print wheels that print a number corresponding to the angular shaft position. Another way is to send a series of pulses which positions a stepping switch connected to the print wheels. Another way is to use a pair of synchro motors, one connected to the rotating shaft, the other to the print wheel. The method used depends on the accuracy required, the space available, the torque needed, and other factors.

Means can be provided for identification of the print; clocks can be attached to print the date and time. Digital data also can be stored, added, multiplied by a conversion factor, or fed into a teletype machine, electric typewriter, punch-card machine, or computer.

*Another term for the analog-to-digital converter is "quantizer."

Typical Systems

The digital converter need not wait for the "automatic plant." It can fit into existing instrument systems in many ways.

The converter can be used to replace nine recording instruments in an existing plant if used as in Fig. 1. Portrayed are two common plant situations—one is which the primary elements produce an electric signal (0-10 mv.) and one in which pneumatic signals (3-15 psi.) are used. The electrical signal inputs from thermocouples or strain gages are attached to nine contacts of a stepping switch. Each of these signals is selected in turn, and impressed upon a self-balancing potentiometer. Attached to the potentiometer, the digital converter reads out the numerical value of the signal and sets the print wheels of the printer. The programmer selects each point in turn and at the same time sets the identifying wheel on the printer to the corresponding point. Incorporated in the printer are year, month, day, hour, minute and second wheels which fix each print in time.

In the pneumatic system the input selector activates solenoid valves which impress the pressure signal from each of the nine points, in turn, upon a pressure transducer connected to a servo system. The servo activates the digital converter. The print wheels are activated by the digital converter, the programmer, and the time clock as in the electrical system.

Data from each of the nine points in each of the systems will be printed sequentially and identified. Two interpolations necessary on a pen recording chart are avoided—interpolation between the chart time lines is replaced by printed time accurate to the second, and interpolation of the third figure of the reading is eliminated by the accuracy of the digital system.

Digital techniques are increasing in importance—owing to inherent high accuracy and versatility. Electric or pneumatic signals of analog type can be converted by digital conversion; teletype facilities make possible remote readout and control.

by M. D. WEISS
Taller & Cooper, Inc.

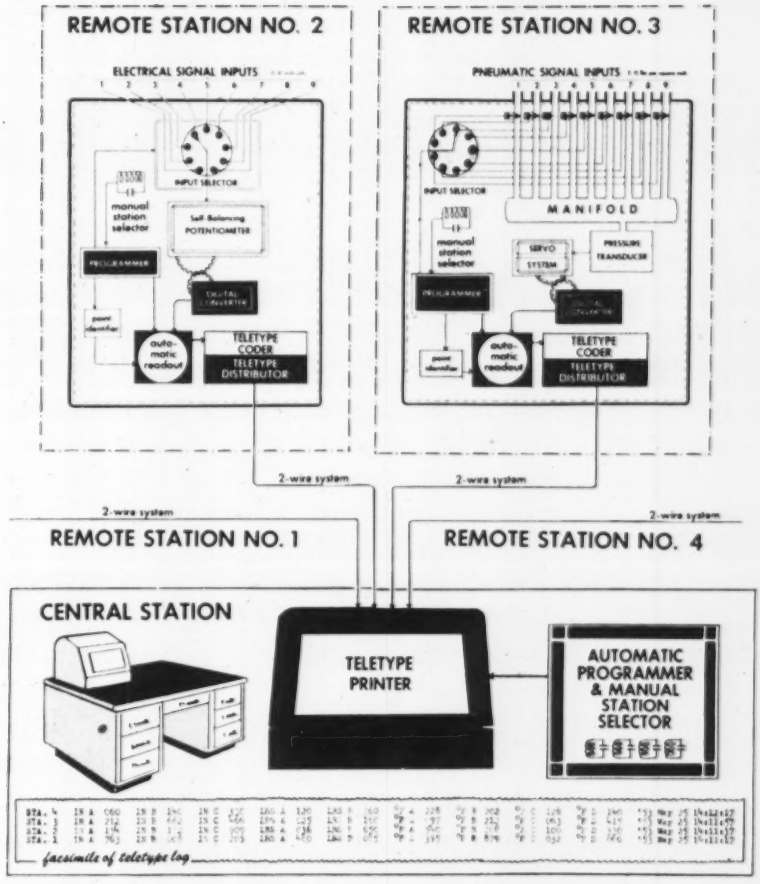


Fig. 2. Digital recording with teletype facilities for remote readout and control.

Remote Control

Use of the digital converter can extend remote control from a remote location in the same plant to a remote location anywhere in the country. In each of the four stations of Fig. 2 the output of the digital converter is impressed upon an automatic readout device which activates a teletype coder. The information then can be sent to any point accessible by teletype.

Control of all the plants of a company can be kept at the home office of the company.

Typical Applications

Applications of the digital converter are numerous and applicable to almost every plant and instrumentation systems. Automatic logging of multipoint temperature installations is one important application. Another is automatic collection of data from an experimental run or pilot-plant operation. A series of thermopiles and strain gages may be connected to the terminals on the stepping switch to signify temperatures and pressures at various points. The test is set up and performed without the handicap of taking data, which is automatically taken throughout the run and printed for subsequent evaluation. The scientist is free to set up a series of tests and be assured that data for each test will be taken automatically for the entire period of the test. Data can be taken on overnight runs: no one need be present to supervise the run.

Often it is desired to print only critical or abnormal data. A multipoint scanner can be used with the digital converter as in Fig. 3.

Of great value are the uses that can be made of digital conversion by management. A production manager in a central office can immediately be made aware of the output at every plant, and his decisions to increase or decrease output at any time can be based on up-to-the-second information. By means of totalizing wheels, the total product or raw material in storage at any second can be printed remotely at a central location for use of management in making decisions. Painstaking inventories can be shortened to merely tearing off a printed tape, with the total inventory given in a second.

Of use to management, research, and control today, the digital converter will be a keystone in the automatic plant of tomorrow.

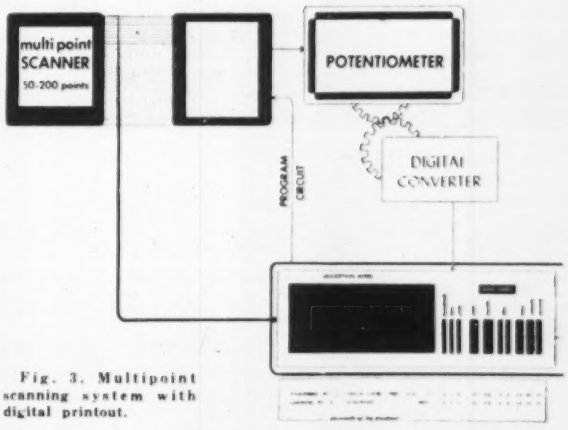
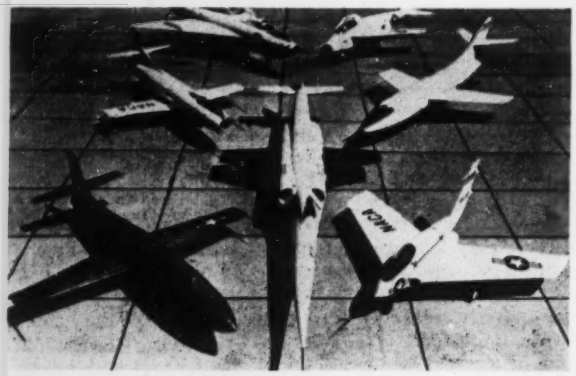


Fig. 3. Multipoint scanning system with digital printout.

FICON project led to successful development of the RB-36D as a carrier or "mother" plane; a "parasite" F-84 has been repeatedly released and returned while the "mother" RB-36D was in flight.

The B-57 Night Intruder, USAF version of the English Electric Canberra, is powered by two Wright J-65 Sapphire turbojet engines. One of its features is a rotary bomb door.

The Fairchild K-44 Camera.



Grouped around the USAF X-3 (Flying Stiletto) from left to right are: the Bell X-1A, Douglas Skystreak, XF-92A, X-5, Douglas Skyrocket, and the Northrop X-4.

"Volscan" air-traffic control center directs large numbers of aircraft arriving at a base; "Volscan" can sustain a landing rate of 120 aircraft per hour—one aircraft every 30 seconds.

CHALLENGE OF

Remarks by Lt. General DONALD L. PRITT, USAF, at 50th Anniversary Dinner, Engineers Society of Pennsylvania, March 10, 1954, Harrisburg, Penna.

FOCAL point of the teamed AirForce-Science-Industry research and development effort is the Air Research and Development Command Headquarters in Baltimore, Maryland. Ten major research, development, and test centers located throughout the country are maintained and directed by the Headquarters of the Air Research and Development Command. These are:

Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. One of the world's most extensive facilities for aeronautical advancement, the Center's program embraces aircraft, guided missiles, power plants, propellers, armament, materials, ground and airborne equipment, aero medicine, aerial photography, and airborne electronics.

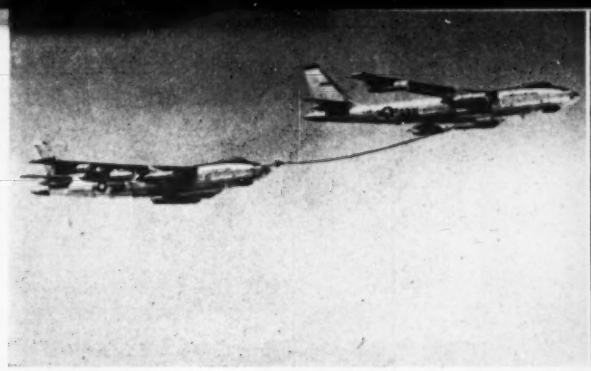
Arnold Engineering Development Center, under construction at Tullahoma, Tennessee; for testing and evaluating supersonic aircraft, guided missiles, and aircraft engines of all types under simulated free-flight conditions. The first completed testing unit of the Gas Dynamics Facility at the Center was "Tunnel E-1," a twelve-inch supersonic tunnel which will be capable of testing aircraft and missiles operating at speeds ranging from 1000 to 3500 miles per hour.

Air Force Cambridge Research Center, Cambridge, Mass.; carries out a broad program in electronics, geophysics, radiobiology, radiochemistry, and nuclear physics.

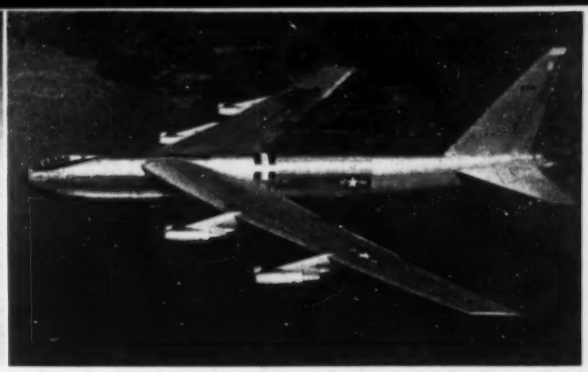
Rome Air Development Center, Griffiss Air Force Base, Rome, N. Y.; ground-base and airborne electronic systems, such as detection, control, identification and countermeasures, navigation, communications, and data transmission systems, and related automatic flight equipment; also systems for intelligence and reconnaissance missions.

Air Force Flight Test Center, Edwards Air Force Base, Edwards, Calif.; flight-tests aircraft and components as complete vehicles and conducts research and development on testing procedures; also maintains USAF Experimental Flight Test Pilot School and parachute test group.

Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Florida; tests long-range guided missiles and target



Probably the world's first jet-powered aerial tanker aircraft, a modified Boeing KB-47B Stratojet (right) fuels the standard B-47 bomber version. The "probe and drogue" system is used.



Boeing's giant B-52 Stratofortress is long-range jet bomber, equipped with eight J-57 turbojet engines made by Pratt and Whitney.

THE AIR AGE

drones over its more than one thousand miles of proving ground stretching from Cape Canaveral, Florida, to a point off the coast of Puerto Rico.

Holloman Air Development Center, Holloman Air Force Base, Alamogordo, New Mexico; tests pilotless aircraft, guided missiles, and related equipment; conducts research and development in space biology; and provides test support to Air Force research programs in guided missiles, electronics, geophysics, physiology, biophysics, and psychology.

Air Force Armament Center, Elgin Air Force Base, Florida; tests aircraft armament systems and components, including guns, ammunition, bombs, and rockets.

Air Force Special Weapons Center, Kirtland Air Force Base, Albuquerque, New Mexico; develops and tests atomic and other special weapons, components, and associated equipment.

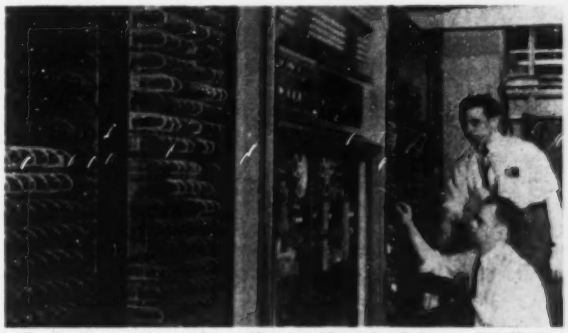
Air Force Personnel and Training Research Center, Lackland Air Force Base, San Antonio, Texas; proficiency evaluation and training of airmen and officer personnel as well as of crews and teams of individuals.

Recent developments include:

1. Automatic high-speed testing of steel fatigue; specimens are magnetically vibrated at frequency of 1050 cps.; an optical pickup provides amplitude and frequency control.
2. A peak stress meter that indicates propeller vibratory stress in psi.
3. New "Volscan" automatic computation and control system for air traffic control.
4. Experimental Arctic radar stations.
5. RC-121C aircraft developed as a flying radar station.
6. New "Automatic sequence selector" uses tape-recorded flight plan to control autopilot in flight.
7. New "A-1" dead-reckoning computer.
8. New "COZI" (communications zone indicator) determines optimum frequency for radio communication under prevailing atmospheric conditions.
9. New speech-compression system that transmits coded signals over 100-cps. bandwidth rather than customary 3000-cps. band.
10. New cameras and mounts, including 5-unit radar camera system, and closed-circuit TV system (Reconoscope) that instantly converts aerial film negatives to positives and displays them on a TV screen.

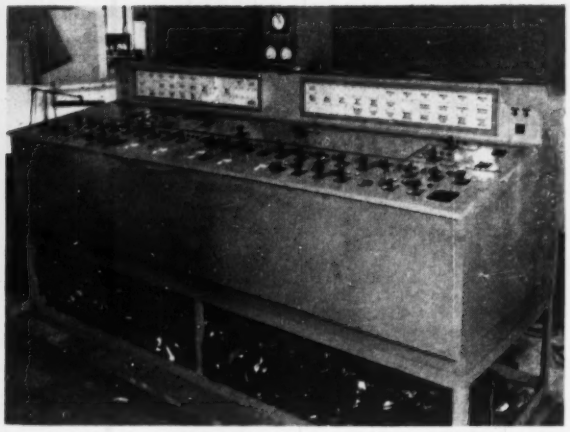
Designed to protect pilots from the dangers encountered in high-altitude flights is the T-1 pressure suit. Also incorporated in the T-1 suit is the anti-G suit, which aids in preventing black-outs under extreme G-pressure.

USAF mechanics at Indian Springs Air Force Base calibrate radio-control equipment in a Lockheed QF-80 drone (pilotless aircraft) which was used in penetrating a radioactive cloud resulting from an atomic detonation during a recent nuclear test at the Nevada Proving Ground. A robot system of Sperry Gyroscope Co. completely controls the QF-80 via remote means.



"ORDAC" digital computer solves problems in design and ballistics. Computer was produced by General Electric Co., working with "ARDC" scientists.

Power-station control room.



Electrical bench board.

The Art of Engineering a POWER STATION

by ROGER E. MARION
Consultant

PINOPOLIS steam-electric generating station was completed recently and put on the line. This station is part of the Santee-Cooper system owned by the South Carolina Public Service Authority at Moncks Corner, S. C.

Description of Plant

The plant follows the modern conventional 2-unit design, comprising the following basic equipment: *Boilers*: Two Riley 460,000-lb. normal capacity, designed for 925 psig., 900 deg. F. from feedwater at 360 deg. F. *Turbines*: Two Westinghouse Preferred Standard Condensing, Automatic Extraction. Nameplate rating 44,000 kw., designed for 850 psig. at 900 deg. each. *Boiler Feed Pumps*: Three Pacific Pumps, Type ABFMB, capacity 567,000 lb. per hour at 1200 psig. discharge pressure.

The feedwater cycle is the conventional five extraction type comprising two low-pressure and two high-pressure closed heaters and one intermediate open-type heater.

Contractural Arrangement

Probably the most unusual feature of the entire job was the contractural arrangement covering the purchase of the control room, the majority of the instruments used throughout the plant, as well as the bulk of the secondary engineering.

It was theorized, early in design stages, that if a manufacturer could be found willing to accept the responsibility of building the entire control room as well as supplying all of the equipment (including all generator and electrical controls) a control room could be produced that would be more pleasing and less costly, both in fabrication and engineering.

Before taking this decisive step, conferences were held with various instrument, panelboard, and electrical manufacturers. Some favored the idea, others did not. Studies were made comparing the cost of controls and engineering handled on the old multiple-order basis with the new system. The single-contract theory promised an overall saving of 25 percent or better.

Four companies were prepared to bid; two panel manufacturers, one instrument and one large electrical manufacturer. The low bidder was the Leeds & Northrup Company of Philadelphia. The contents of the specifications required the successful bidder to furnish all control equipment, the complete control room excepting the ceiling, and about 75 percent of the controls not in the control room. All boards had to be completely wired and piped.

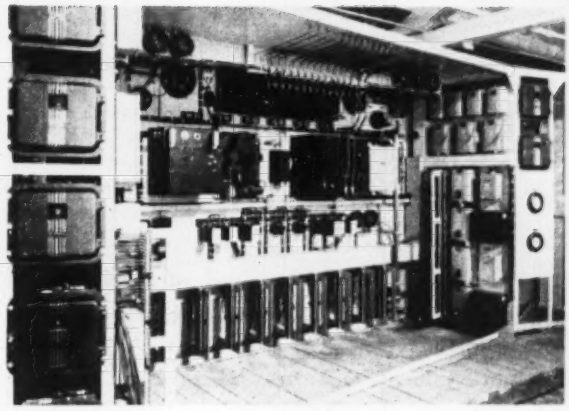
The low bid was some $33,000 below the previously prepared estimate; the office drawings were reduced from the usual 35 to 17, including the instrument list. This is the second contract of this type in which the writer had a major part. One might say this is the modern way of solving one phase of the control situation.

Consideration of Control Room

During the past it has been common practice to consider first the larger features of the plant (boilers and mills, turbines, boiler feed pumps, etc.), then to design the building to house these units. Control was rarely, if ever, given any consideration at that time. On this job, early consideration was given to various types of controls. A central control room was decided upon.

At this point we departed from general boiler-plant design practice. We made a study of the manpower requirements based on a central control point. The problem then was resolved into the number of men required per watch and the respective duties of each man.

Having assigned duties and stations to each watch operator, it then was necessary to locate the control room. Consideration of all factors led to choice of a centrally located point between both boilers, straddling the main east-west



Inside boiler board.

center aisle, elevated above the operating floor. A mezzanine floor was erected in the heater bay, elevated fifteen feet above the operating floor and centrally located along the main north-south center aisle.

A gallery was added on the north and east walls of the turbine room to provide for visitors to view the plant without interfering with plant operation. This provision was included at the request of the owner.

One important feature provided by this location, a feature we have strived for in all plant designs, is complete unrestricted movement along all operating floor aisles.

Selecting Control System

In selecting an automatic control system, the determining factor never should be the comparative cost. Difference in cost between various manufacturers can never be so great that more important considerations can be disregarded.

It is bad engineering also to select a control system on the basis of personal preference. Of the two main divisions, electric and pneumatic, each has its use. In the scientific analysis of both systems one must discover which meets the technical requirements best; such as the relation of fuel feed to air flow, the system of governing fan and other dampers, various interlocks and safety features, speed of response, and difficulty of installation. Space occupied by drive units is an important factor. Of current interest in modern developments is the space occupied by the control-room instruments themselves.

As the owners of the plant had more knowledge of electrical controls than of mechanical or pneumatic systems, we were influenced towards an electrical system.

We had already formulated the general plans of the room, which included two console-type bench-boards—one for generator controls and one for boiler and feedwater controls. Inclusion of the operating controls on the console established the approximate dimensions of this unit. As there were some 120 to 140 controls to be mounted, we made a close study of the types available. Modern miniature controls were given long and careful study.

On the vertical boards we had ample space for full-sized recorders and gages. As the operator may stand 15 feet away from the vertical boards, miniature instruments could not to be used on the vertical boards.

The bench boards had to be as small as possible and still contain some 140 instruments: 70 for each boiler. Miniatures were therefore given serious consideration. As the General Electric Co. SB-1 switch requires less surface area than any other type of control, use of this switch (identified with electric controllers), plus the owner's electric experience, established the electric system as being the most desirable for this plant.

After a cost comparison of the various competitive systems (including mechanical), specifications were prepared around the Leeds & Northrup system, with no alternates.

Following the same analytical method, the feed-water regulating and boiler feed recirculating were awarded to Republic Flow Meter Co.; they also had to furnish the feed-water recorder. Thus our basic system was formulated: a manufacturer was required to furnish all the incremental parts of any system he provided.

In restricting the number of manufacturers involved, we simplified the maintenance. All recorders are either Leeds & Northrup or Republic. All indicating meters are Westinghouse; operating switches are all General Electric SB type. All control-room pressure gages and their transmitters are Ashcroft. All level indicators and draft gages are Republic. The several hundred pressure gages installed throughout the plant are all Helicoid; the large quantity of thermometers are all Palmer. All level control valves are Climax; temperature control valves are Leslie.

The shape of the control room was given considerable attention. A semicircular shape finally was adopted. The colors involved were also subject to a thorough investigation. We rejected all blendings and mixtures and concentrated on these acceptable colors that could be ordered by direct number.

The ceiling and lighting came in for the same intensive study. Instruments had to be brightly lighted; reflection and glare eliminated.

The highest exemplification of art in engineering is found in the arrangement of control room instruments. Consideration must be given to ease of observation and operation, sequential or related arrangement, and convenience of manipulation and maintenance.

Annunciators

One unique feature gives satisfactory results—annunciators are divided into individual cabinets. Each cabinet contains alarms relative to instruments located directly below the annunciator. At the sounding of an alarm a plate at the exact center of the cabinet is illuminated in bright red simultaneously with the sounding of the horn and illumination of alarm nameplate. As there are 13 alarm cabinets in the room, this red light enables the operator to instantly spot in which cabinet the alarm is activated. Each cabinet is informative by its location; it tells the operator whether the signal concerns unit No. 1 or 2, whether it is boiler or turbine trouble, etc.

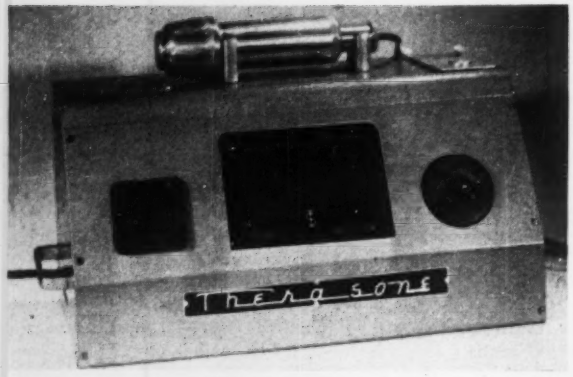
Use of pneumatic-loaded level indicators gave birth to another innovation that simplified the alarm system; we simply use an inexpensive Mercoid switch mounted on the air loading line close to the annunciator. The same plan was used for signalling high and low pressures.

We studied every instrument that went into the plant. Arrangement of all instruments was done by our own instrument department; we do not rely on the instrument manufacturer to design our boards. Even instrument nameplates had to undergo exhaustive research and study.

Noise Reduction

Noise reduces worker efficiency and costs the employer money. In this plant we broke with tradition and installed a ceiling in the turbine room. This increased the plant cost about 7c per kilowatt. But the reduction in noise was remarkable; it is possible to stand on the turbine floor between both generators and carry on a conversation in normal tones.

Ultrasonics in Medicine



Ultrasonic generator.

A growing field for application of ultrasonics is in therapy and surgery. Important factors include absorption, acoustic velocity, acoustic impedance, parts velocity, and ultrasonic pressure.

by F. NIESEMANN
Professional Engineer

IMPORTANCE of ultrasonics and its application in the medical field is growing. Ultrasonic sound consists of sound waves with frequencies above the audible range—that is, above 15 kc. It is propagated by longitudinal waves, which are alternating compressions and expansions of the transmitting medium. Therefore, it is a pure mechanical wave which is usually produced by electronic means.

The classical theory of sound applies also to ultrasound. However, the energy output is quite different: the maximum sound energy of a therapeutic machine, about 40 watts, is several million times more than the energy output from an average loudspeaker.

As the frequency of a wave increases, the sound wave can more easily be made directional—that is, it can be made to take the shape of a beam. This feature is important for therapeutic work because it permits a concentration of the sound energy.

Characteristics of Sound Waves

In ultrasonic application, water displays properties similar to body tissue. The following characteristics are based on a 100-kc. wave, with intensity of 4 watts/cm.^{2}, in water.

Absorption of the sound power increases with the frequency. Therefore, frequencies of 500 to 3000 kc. usually are used for medical purposes because this range combines good directional characteristics with sufficient penetration. Most therapeutic equipment today is based on a frequency of 1000 kc. The common theory for the absorption of sound energy cannot be applied in the biological field because tissue is not homogeneous material and the absorption depends on the tissue structure. The penetration of sound energy (the inverse of absorption) is measured by its half-value—that is, by the depth at which the sound energy has been reduced to 50 percent of its original strength. This penetration is approximately 3½ cm. for muscle and 6 cm. for fatty tissue if a frequency of 1000 kc. is used.

Presented before the Institute of Radio Engineers at the Mellon Institute, Pittsburgh, Pennsylvania, Oct., 1953.

All sound, audible as well as ultrasound, is propagated at an *acoustic velocity*, which is independent of frequency or amplitude but depends on the transmitting material, especially on its density and its elastic modulus. The acoustic velocity is approximately 1500 m./sec. for water, 332 m./sec. for air, and 5700 m./sec. for quartz. Note that the acoustic velocity varies in different materials.

Acoustic impedance is the product of acoustic velocity multipled by the density of the medium. For water, it is 3000 times that of air; for quartz it is 30,000 times higher than for air.

The *wavelength* of a 1000-kc. wave (velocity/frequency) is 0.15 cm., or approximately 1/16 inch.

The *parts velocity*, or the drift, is 23 cm./sec. for water: the amplitude is approximately 3.7×10^{-6} cm. This small amplitude, together with the short time interval during one oscillation, necessitates a very high acceleration—approximately 160,000 times greater than the gravitational acceleration. A common pencil would weigh approximately 1 ton if it were exposed to such an acceleration.

The *pressure amplitude* in the compression wave is 3.54 kg./cm.^{2}, or approximately 50 psi.—that is, a pressure change of ± 50 psi. takes place a million times during every second.

The *irradiation pressure* is the force on a reflecting area. This has become important because it serves as a means of measuring the ultrasonic power output of a transducer. It is 272 mg./cm.^{2} if the intensity is 4 watts/cm.^{2}

Effects of Ultrasonics

All energy is changed ultimately into heat: ultrasonic energy is no exception. Heat has always been considered to have a great therapeutic value because it stimulates every other process. Ultrasonics have, therefore, some kind of diathermic effect. However, their real value is in what happens during the period before the sound energy is fully converted into heat.

The intense pulsing of the sound wave due to the expansion or compression period is a form of high-frequency

massage in the human tissue. As a result, we observe hyperemia due to an increase of local circulation. This pulsing also may be partially responsible for the increase in permeability, which in turn increases the intercellular osmotic exchange. The pulsing may be credited also with the release and activation of oxygen and its transformation to hydrogen peroxide. These effects may be important because many diseases are caused by ischemia, which is a local deficiency of oxygenation.

Other effects in the human body are the release of histamine, vasodilation, etc., which are usually explained by the irritation theory.

Ultrasound relieves spastic conditions, especially if they occur in the form of muscle rigidity; the mechanism is not fully understood.

Most important for the therapeutic effect of ultrasonics is the pattern with which the sound energy is distributed. Instead of being evenly absorbed, it is released in those locations where the sound beam finds resistance—that is, where there is a change in ultrasonic impedance. Thus, ultrasound has its greatest effect where there are bones, interfaces, or any other changes of tissue structure. This effect cannot be obtained by any other means.

The technical applications of ultrasound include emulsification of immiscible fluids, dispersion of solids, coagulation, thixotropic phenomena, polymerization and depolymerization, cavitation, etc. It is doubtful whether these effects are active in therapeutic applications because the energies used in the latter are too low to be effective in this regard. However, they play their part if ultrasound is used in surgery—that is, where it is applied for the destruction of tissue.

"Therasone"

The "Therasone" ultrasonic generator (Fig. 1) has been used in recent experiments. It consists of a power supply, an oscillator, an amplifier, and a transducer crystal. The frequency of 1000 kc. is controlled by a small control crystal in the oscillator circuit.

Modulation is provided in the form of an interrupted wave, which is measured in percent of the "on" period. The purpose is to reduce the total sound energy or heat input into the body, thus permitting a high intensity without unduly raising the temperature of the tissue. This method avoids pain at the periosteum of the bones when applied for arthritis, or nerve damage in neurological applications.

A small oscilloscope is provided for observing the wave form during the application. The oscilloscope shows an increase of the amplitude when the sound energy is transmitted into the body. Thus, the physician can observe whether good coupling has been obtained.

As air blocks ultrasound, a coupling substance must be provided. Treatment under water, or the application of a film of white mineral oil on the skin have proved most suitable. The sound treatment is usually carried out by a stroking massage. If the stationary method is used, the intensity must be reduced to approximately one-tenth of that used in the stroking type.

Neuralgic condition, arthritis, painful joint condition, bronchial asthma, peptic ulcers, etc., respond to ultrasonic treatment. Recently, treatment of the nerve roots and nerve ganglia at the spine has been recommended. It is effective for relief of spastic conditions. Analgesic effect (pain relief) often is observed after one application.

Varicose ulcers, furuncles, paradentosis, and peripheral disorders with neural background form another group of diseases which have shown excellent improvement by use of this therapy. A warning has been given with regard to ultrasonic treatment of malignant tumors because it may impel their spread to other parts of the body by metastasis.

As pain is a warning that ultrasonic intensity used it too high, anesthesia should not be used. On the other hand, in surgery, tissue is destroyed and anesthesia may be necessary. With the knife, we eliminate parts of the body, whereas with ultrasonics we obtain a necrosis by attacking the metabolism, whereby the damage to the tissue is so minute that it can usually not be discovered even with the best microscope. What is seen in histological slides is the degeneration which occurs afterwards. Ultrasonic techniques may simplify and improve many procedures in surgery. A necrosis can, for example, be obtained in the center of an object without damaging the outside, which may be important in many operations.

SAMA 36th Annual Meeting

THE 36th annual meeting of the Scientific Apparatus Makers Association was held at the Broadmoor, Colorado Springs, Colorado, May 2-7. The annual public information panel discussed "Science's Debt to the Toolmaker."

Charles Honeywell, Administrator of the Business and Defense Services Administration, U. S. Dept. of Commerce, pointed out that the nation's $3.5-billion research program depends largely on products of the instrument industry.

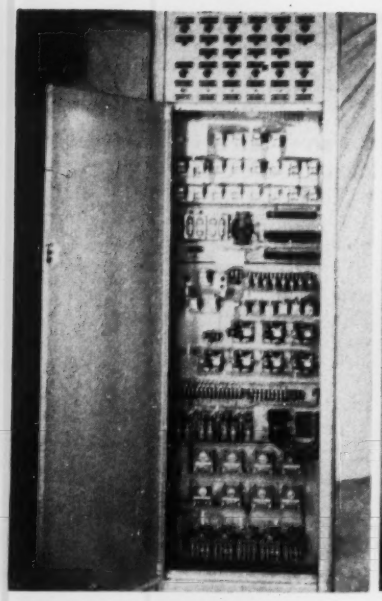
E. J. Rhein, of Kimble Glass Co., called attention to the increasing flood of imports. Rhein, chairman of the laboratory apparatus and optical sections, pointed out that the strategic importance of the industry has not been recognized by Foreign Economic Policy Commission.

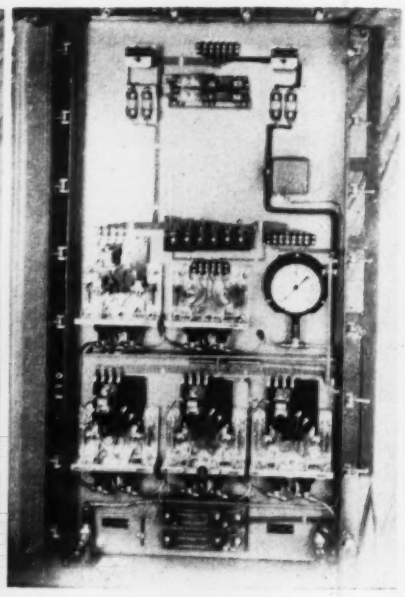
Dr. W. E. Shoupp, Atomic Power Div., Westinghouse Electric Corp., discussed "scientific apparatus and instruments as tools in the atomic energy program." He pointed out that nuclear studies have called for a new order of reliability in instruments.

Edward J. Albert, president of Thwing-Albert Instrument Co., was re-elected president of SAMA; *T. M. Mints*, president of E. H. Sargent & Company, also was re-elected to another term as treasurer.

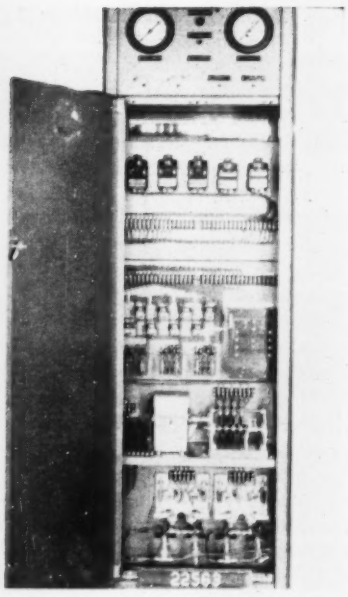
Newly elected chairmen of the association's six sections are: Industrial Instruments—*J. Robert James* (James G. Biddle Co.); Laboratory Apparatus—*E. J. Rhein* (Kimble Glass); Laboratory Equipment—*O. L. Lethander* (Leonard Peterson & Co.); Optical—*L. B. McKinley* (B&L Optical); Nautical, Aeronautical, and Military Instruments—*P. R. Bassett* (Sperry Gyroscope) and *B. H. Bristol* (Foxboro).

Directors-at-large include: *C. G. Campbell* (Kewaunee Mfg.); *H. F. Dever* (Minneapolis-Honeywell); *A. W. Fisher* (Fisher Scientific); *H. B. Richmond* (General Radio); *G. W. Tall* (Leeds & Northrup); and *R. E. Welch* (Welch Mfg.)





The City of Two Rivers, Wisconsin, has a 4-pump "Telestep" unit with a Transmitter (left) mounted at the base of the tank and a Receiver (right) at the pumping station. The Transmitter controls the 4 pumps in 6 steps and transmits a high and low alarm signal over a single pair of wires to the Receiver.



The St. Bernard Parish installation is a less complex unit for control of 3 pumps in 4 steps, including low-suction-pressure cutoff and alarm.

Water-distribution Systems Require

PUMP CONTROL

Important factors in design of pump control for a water-distribution system are (1) demand range, (2) type of water system, (3) pump selection, and (4) telemetering.

by J. S. WILLIAMS
Automatic Control Co.

PUMP CONTROL is a relatively new field of instrumentation; the industry goes back to 1923 when the first elevated tank control was conceived. In those early days it was a major problem merely to start and stop the pumps due to lack of experience on surge problems, friction variable, and other operational difficulties.

Today's problems are broader in scope and place emphasis on the over-all distribution problem. Although every water-distribution system differs from all others, distribution systems fall into two general classifications within which there are certain common characteristics—the two broad classifications are municipal and industrial.

The major difference is the nature of the demand load. The municipal demand changes slowly, whereas the industrial is literally whole hog or none. For example, in plant processing or cooling-water applications there exists a continuous high-load condition, but a rest period or shift change drops the load to virtually zero.

Basic Water Systems

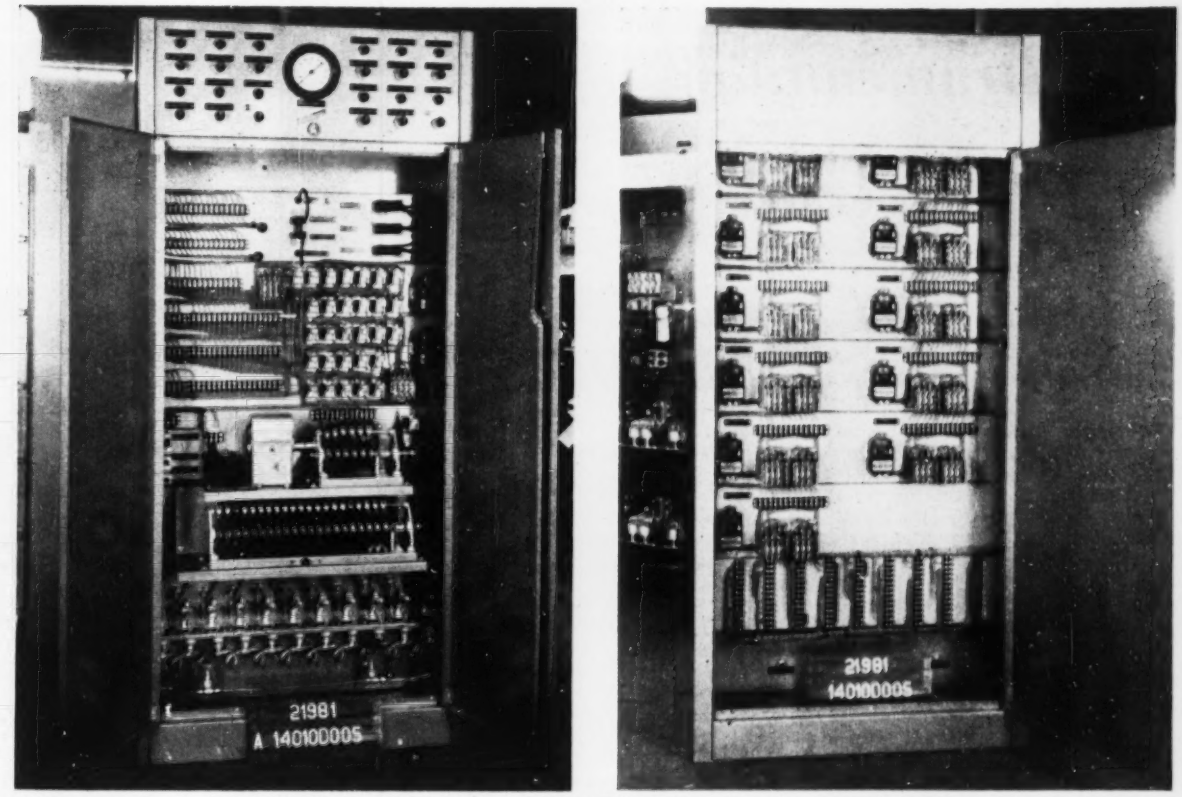
Within the two broad classifications (and common to both) are three basic types of operation—the reservoir system, the pressure system, and the closed system. The former is the most common and includes any system with elevated tanks, standpipe, or reservoir that rides on the distribution system to stabilize the pressure and to provide reserve supply under outage or emergency conditions.

The second category, the pressure system, is confined to the hydro-pneumatic tank. In this system the complete supply comes from the pumping source, and the sole function of the tank is to stabilize the system, not to provide storage. Actually, the sole function of the hydro-pneumatic (or pressure) tank is to permit efficiency in control. This type of system, on larger systems, will be obsolete when a majority of engineers and users understand the principles of the third category.

The third category, a closed system, is a system which has no reserve or stabilizing influence in the form of storage tank or hydro-pneumatic tank, but which meets the varying demands directly from a pumping source. This system, although appearing revolutionary, is evolutionary. The closed system is a truly engineered system wherein the entire operation reduces to a graph prior to purchase of components.

Design of a closed system starts with consideration of the demand load from minimum to maximum. We then establish the desired pressure norm with full consideration to the system friction losses, variable suction pressure, and other factors. We then carefully select the pumps to pro-

Presented at Conference on Instrumentation In Water, Sewage and Industrial Waste Treatment, May 14, 1953, Manhattan College, N. Y.



Closed System, recently built for the U. S. Steel Company, Fairless Works, is designed for 6 present and 5 future pumps in a 27-step program for flows varying from zero to 200,000 gpm. Shown are front and rear views.

vide the desired operation and, from the graph, pre-determine the efficiency and stability of the system. The pump characteristics determine the deviations from the norm.

Such engineered systems meet present-day objectives in control. It is designed from a standpoint of control, and coordination of all components is essential. Ten years' field study and practical experience show that this system is more efficient than any hydro-pneumatic system and, with qualifications, superior to the elevated-tank system. Standby motive power for outage should be installed in a closed system.

Pump Selection

There is a vast difference in the selection of pumps for closed systems and for the other two types. For the latter, a "steep curve" is preferable. This is one which delivers a relatively constant discharge-rate despite varying suction discharge or other pressure conditions. In other words, the pump delivers relatively constant flows while tolerating broad pressure changes. This pump is totally unsuited to the closed system, which requires the opposite characteristics—a pump which has a relatively broad change in discharge rate within small pressure differences. This is the method by which varying demands are balanced within minimum pressure limits.

Telemetering

Many water-distribution systems just grew until they reached the point where the pressure at one location had no particular bearing on conditions existing at another. To control from the pump site, the pressures registered there must be an accurate reflection of level in an elevated tank. Where intervening drawoff exists in any substantial proportion between the pump and tank, it is necessary to seek out a point where the measurements will be stable, consistent, and a true reflection of tank level; these conditions always exist directly at the reservoir proper.

The industry must, therefore, transmit such intelligence back to the location of the well or pump. These transmission methods are known as telemetering. Various forms of transmission are used in telemetering.

Carrier-current systems—over existing power lines, private cable, or leased telephone lines—are one form of telemetering. This type was basically designed for the supervisory control of power sub-stations. In power distribution this type of system generally operates from frequency-sensitive relays and has certain basic features, such as reporting signals, required for power distribution. There is one fundamental difference between power sub-station supervisory control and water-system use. That difference is in personnel. The power company must employ skilled electrical engineers capable of dealing with electronic problems arising in the maintenance and operation of supervisory control; water departments do not usually employ electrical engineers.

Radio transmission also has been used experimentally.

One of the oldest types of transmission is referred to as the *time-impulse method*, designed for recording purposes. It is basically mechanical and hence is more vulnerable to wear than a purely electrical system. The electrical system, because of the components used, is basically sounder. The time-impulse system is occasionally used for control, but the equipment was originally designed for recording purposes. In addition to these there are the dial system, microwave system, and others.

Once the primary controls are selected for operation of the system, any one of the various types of transmission schemes can be utilized successfully. The type of transmission selected should depend on the type of personnel, the reliability of the equipment, and installed cost. Autocon has developed an all-electric transmission system designed for the equipment and personnel of the water and sewage field.

Instrumentation of

Industrial Waste Treatment

Basic uses for instrumentation in industrial waste treatment include waste surveys, control of the treatment process, and monitoring. Problems and typical solutions are presented.

by JOHN J. BAFFA
Consulting Engineer

INSTRUMENTS are used in all methods of wastes disposal which include discharge to municipal systems or streams or ground waters. Discharge to disposal may be made after complete treatment, partial treatment, or no treatment by the industry.

Waste flows, fluid flows, liquid levels, temperatures, and waste and fluid quality characteristics require measurement in order to (a) design the collection and treatment facilities, (b) provide for control of treatment processes, and (c) monitor waste-contributing processes, treatment-plant influents and effluents, and receiving waters. Instruments also provide data for improvement of existing plants, for future designs, and for stimulation of research.

Industrial waste discharges are generally characterized by extreme variability of flow and quality.

The Industrial Waste Survey

Instrumentation applications to obtain the data necessary to solve an industrial waste-disposal problem include field measurements of waste flow and quality, quality measurements made in the laboratory, and automatic recording of pilot-plant flows and pilot-plant influent and effluent quality. Some of these measurements are necessary not only for the waste discharges but also for the receiving waters or municipal facilities.

Flow usually is measured by use of weir, orifice, Parshall flume, Venturi tube, positive-displacement meter, or pitot tube. Automatic recording of the flow for a sufficient length of time to establish its peculiarities provides basic design data. In some instances several flow-measuring units may have to be installed to measure flows from several of the manufacturing processes in the same plant in order to permit calculation of component quality considerations. In this manner, leakage and losses may be isolated and corrected to reduce volume of flow to be treated, and thus increase manufacturing efficiency.

Flow measurements also provide necessary data or actuating means for manual or automatic sample compositing. Fig. 1 shows a waste flow pattern over a one-day period for a plant manufacturing cosmetics. Like most industrial waste flows, it is variable over a wide range.

Quality determinations during the survey period involve instrument applications which include recording pH meters and conductivity meters, recording temperature gages, turbidimeters, photometers, and oxidation-reduction measuring devices.

Control of Treatment Processes

When complete treatment of waste is practicable, instruments and control systems provide (a) uniformity of effluent and (b) maximum operating efficiency.

Instruments can be provided to facilitate manual control or to provide automatic control of both batch and continuous waste-treatment processes. Thus, from flow meter and pH meter records which show a definite pattern the operator can manually set chemical feed quantities as required. As a further step toward automatic control, feed settings may be automatically changed by time controls. Where widely variable conditions are encountered or where considerable sensitivity of process is involved, automatic proportioning of chemical feed in accordance with pH or conductivity or flow may be necessary. Uniformity of effluent is important in many applications and can be achieved best by automatic proportioning of chemical feed according to flow or quality variations.

Operating efficiency is, as a rule, greatly increased by application of automatic control to chemical proportioning. Labor costs are saved, human factors are eliminated, waste

Presented at Conference on Instrumentation In Water, Sewage and Industrial Waste Treatment, May 14, 1953, Manhattan College, N. Y.

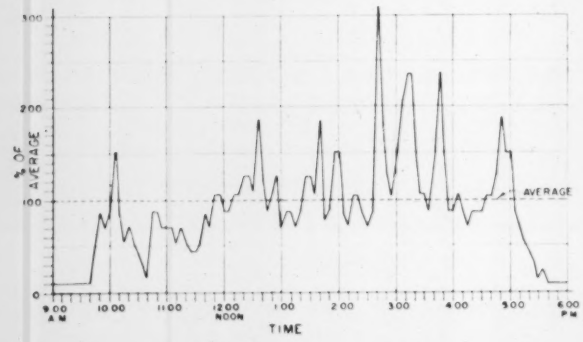


Fig. 1. Industrial waste flow.

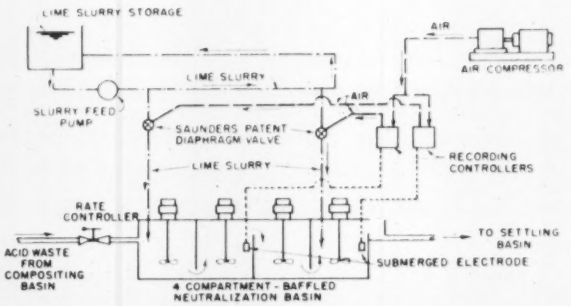


Fig. 2. Acid waste neutralization chemical feed automatically proportioned according to pH.

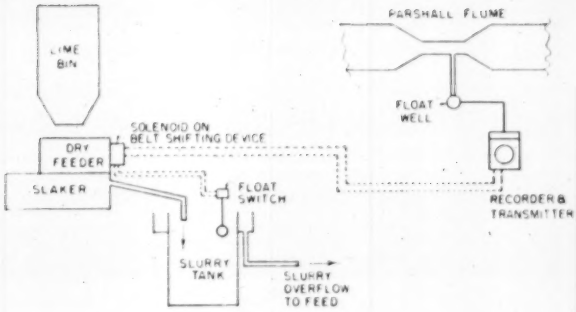


Fig. 3. Coagulation of flue-dust-waste slaked lime feed proportioned according to flow.

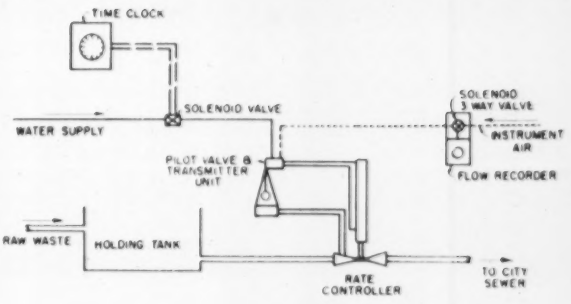


Fig. 4. Timed control of waste discharge to municipal sewer.

of chemicals through over-dosage or possible corrosion through under-dosage are absent, and highly trained personnel are left free for other tasks. Other applications providing for increased efficiency include automatic flue-gas sampling and automatic recording of conductivity or pH to indicate wastage of raw materials.

An example of chemical feed proportionment in accordance with quality variations is shown in Fig. 2. The application was made to the neutralization of an acid waste from the manufacture of dyes. Flow control after compositing, utilizing a Simplex Valve and Meter Company controller, was provided to permit eight-hour (1-shift) operation of neutralization facilities as well as to eliminate the flow variable. The basin dimensions were based on reaction time (determined in the laboratory) and the total volume divided into four over-and-under-type baffled compartments, each provided with a stirrer.

Two-point control was chosen in the interests of efficient reagent usage and maximum effluent uniformity to prevent after effects in the receiving stream. Lime slurry was planned for continuous circulation with feed point take-offs through Saunders Patent diaphragm valves, pneumatically positioned. The recording controllers installed were Leeds and Northrup pneumatic controllers with proportional, reset, and rate action. Immersion-type pH-electrode assemblies with plastic head were installed in the locations shown.

With changes in pH, the controller increases or decreases slurry flow through positioning of the diaphragm valve. The amount of increase or decrease of slurry flow is proportional to the extent that pH deviates from control point setting and to the length of time that the deviation exists. Operation for several months indicates that with a influent pH varying from 3.0 to 4.0 the desired effluent pH of 6.0 can be maintained with little if any variation.

In another application, shown in Fig. 3, lime feed is proportioned in accordance with flow by using a Parshall flume. In this instance, flow changes are gradual and quality of waste is relatively uniform. The recorder and transmitter were supplied by Builders Iron Foundry and the dry feeder by Omega Machine Company. The transmission from the primary device to the transmitter is hydraulic, thence electrical impulses signal the solenoid at the dry feeder. The solenoid positions the belt-shifting device controlling feed rate. The float switch in the slurry tank is a safety precaution and stops the feeder and slaker discharge to the slurry tank if slurry lines should clog and the tank fill above normal level. Feeder and slaker will start when tank level recedes to normal.

Where flow changes are abrupt, and quicker response to flow changes is required, this same system is applicable except that the belt-shifting device would be eliminated and the transmitter impulses would actuate a control valve on the slurry tank outlet, with slaker rate chosen slightly higher than lime demand.

Other applications of automatic control in industrial waste-treatment include automatic control for digestion tank temperature and gas pressure, sludge conditioning pH, and automatic bar screen and tank mechanism operation.

Monitoring Services

Monitoring instrumentation is of extreme importance to provide (a) for operator and community safety, (b) safeguards for receiving streams or municipal systems, (c) basis for municipal or sewer authority charges, and (d) records indicating that stream regulations have been met.

Instrumentation for safety purposes includes automatic gas analysis for methane and inflammable or toxic gases, automatic recording of chlorine residual, and detection of radioactive substances. Automatic recording of flow, effluent pH, conductivity, and oxidation-reduction potential provide measures of effluent character. Alarm systems can be provided for instantaneous warning of treatment process or manufacturing process failures, or losses such as might affect treatment or disposal. The stream or receiving system is thus safeguarded. Such instruments also protect the industry against charges of having discharged pollutants such as may have caused injury. Study of records also can eliminate waste and improve process efficiency.

Municipal regulations affecting waste discharges into sewers and sewer rental laws have broadened the field of instrumentation. Municipal regulations control the quantity and quality of waste discharges for the protection of municipal sewers and treatment plants against deterioration and process upsets and, in many instances, charges have to be made for handling industrial wastes. However, many industries find that disposal to municipal systems provides an economical solution to their waste problems.

An example of facilities for controlled discharge of untreated industrial waste to a municipal system is shown in Fig. 4. The purpose of the design is to discharge a maximum of the waste during time of minimum sewage flow to a municipal sewage-treatment plant. No pre-treatment of waste is required; the waste is such that no sludge would be formed in the holding tank. The rate controller is Builders Iron Foundry "Model RCB." At predetermined time set on the time clock, the rate controller is opened to predetermined rate by the pneumatic control system; after a pre-set time interval, the controller is closed.

Problems

Applications of instrumentation to industrial waste-treatment involve many problems to the sanitary engineer, the instrument manufacturers, and the instrument engineer.

Primary devices for flow measurement and hydraulic transmission often must carry solids and require purging. Solids and grease can plug sample lines, coat and poison electrodes, and weigh down floats.

Corrosive liquids and fumes have to be handled, requiring suitable choice of materials.

Sensitivity of control over a wide range of flow or pH require special consideration. Sample points are subject to difficulties occasioned by short circuiting through tanks and addition of reagents in dead spots.

The sanitary engineer should be familiar with instruments, the principles of their operation, and their applications. He should be able to define a given problem to the instrument specialist, including legal, hydraulic, chemical, and biological requirements.

Counting-timing Techniques for

FLOW CONTROL

A counter and an automatic-reset timer, used with a contact-type positive-displacement flowmeter and solenoid valve, is a flexible device for automation of flow processes. Such "digital" techniques are particularly adaptable to batch and proportioning applications.

by M. G. SAAKE
Ribble Engineering Co.

INSTRUMENTATION by timing and counting technique is utilized increasingly in the trend to complete automation of machines and processes. Use of timers and counters is particularly successful in batch metering and proportioning.

The basic instrument is a positive-displacement flowmeter with a contact-making mechanism. This contact closes momentarily with the passage of a precise volume of liquid, cycle after cycle; this establishes a reference point for the controlled process. Timers, counters, and associated components are then added to make the system predetermining and fully automatic.

Fig. 1 shows a meter-counter combination designed to deliver a preselected volume of liquid. The counter receives electrical impulses produced by the contact in the meter, and operates as a relay when the number of impulses received corresponds to that of the counter dial setting. For example, with each meter contact closure representing the flow of 10 gallons of liquid, and with the counter set at 27, pressing the "start" button will initiate the process by opening the valve, 270 gallons will flow, after which the valve will automatically close.

Proportioning

In applications involving proportioning of continuous flows, such as adding a volume of chemical reagent to a larger volume of water, a timer and a double-pole relay are added to the system (Fig. 2).

The flowmeter and counter operate as described. However, when the counter "counts out," it energizes the timer which then turns on the proportioning pump The pump operates for a timed interval, thus introducing a definite quantity of liquid in relation to the main flow.

Flow Rate Control

The same components can be arranged to act upon speed-up or slow-down of flow—that is, to operate on the rate of meter-contact closures. This finds application where one source is adequate to cover normal liquid consumption, with a second reserve supply ready to take care of abnormal usage. The system immediately detects a speed-up of flow, adds the second supply, and returns to a single source when the need passes.

As an example, assume that normal flow causes four meter-contact impulses per minute, with impulse rates above this calling for additional volume. Referring to the schematic wiring diagram of Fig. 3, normal operation is as follows:

1. After line switch is closed, first closure of meter contact energizes count coil and relay coil CR1.

2. CR1 contact closes, energizing both timer 1TR and counter clutch coil, which are both maintained by timer contact 1TR. Timing begins and first meter contact is registered.

3. Counter continues to register impulses fed to it by the meter contact. If these are fewer than the number set on the dial of the counter and occur within the interval of the timer setting, contact 1TR opens. The timer and counter reset to zero, beginning a new cycle upon the next closure of the meter contact. Normal operation continues in this manner.

If, however, there is a speed-up of meter-contact closures, the system operates as follows:

1. The same action occurs initially as described in paragraphs 1 and 2 above.

2. Counter continues to register impulses fed to it by the meter contact. If the number set on the counter dial occurs before the time set on the timer dial, counter contact to relay coil CR2 and solenoid valve closes. These load circuits are maintained by relay contact CR2 in series with closed contact 2TR of timer 2TR.

3. At the same time, the second counter contact closes to energize the clutch coil of timer 2TR. This timer is arranged for reverse clutch operation; namely, when the clutch coil is energized, the clutch is held disengaged and the timer is prevented from timing. Under this condition, the timer is in its reset position.

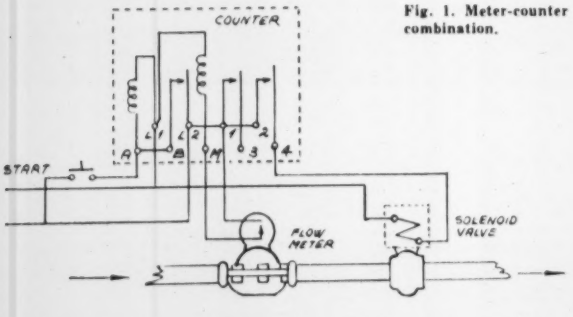


Fig. 1. Meter-counter combination.

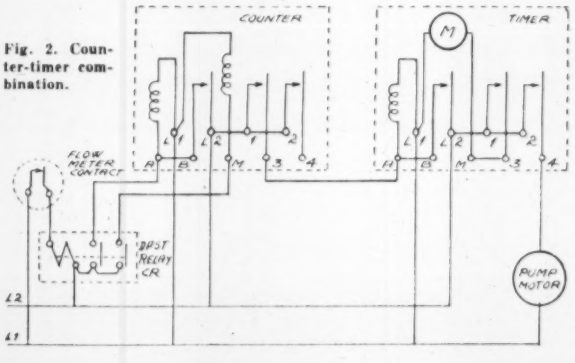


Fig. 2. Counter-timer combination.

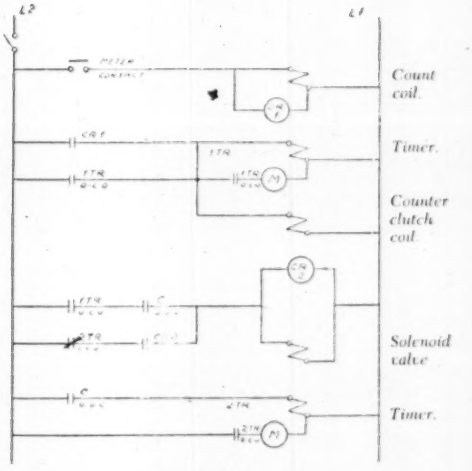


Fig. 3. Flow rate control.

4. As soon as the counter "counts out," its contact to the clutch circuit of timer 2TR opens and timing begins. If the abnormal rate of meter contact closures persists, timers 1TR and 2TR always reset before reaching the "timed out" position; relay CR2 and solenoid valve remain energized.

5. When the meter contact closure rate returns to normal, the counter does not reach its predetermined count within the timer limit of timer 2TR setting. This permits timer 2TR to complete its cycle and time out. When it does so, its 2TR contacts open, breaking the CR2 relay and solenoid valve circuit, restoring this part of the system to normal.

6. Valve to the stand-by supply source closes, and liquid is now flowing from first supply only.

The same system detects slow-down of supply.

These systems are fully automatic and, within the limits of the accuracies of the components, deliver precise outputs. Circuit flexibility also is noteworthy. A variety of conditions can be met by modification of these units. Applications of these types are good examples of the manner in which the automatic-reset timer and counter contribute to automation.

ACKNOWLEDGEMENT

Terminal arrangement of the timers and counters is that of Eagle Signal Products.

Use of Oscilloscope for Measurement of Potential Difference

By FRANK T. TURNER
Western Union Telegraph Co.

In the study of electronic circuits the problem frequently arises of determining the instantaneous difference in potential between two points in the circuit. If one of the points is grounded and a cathode-ray oscilloscope connected between the points, the desired information is immediately presented. However, circuit impedances or terminal devices occasionally will not permit this, and an oscilloscope with a differential input amplifier is required. When such equipment is not available, the usual recourse is to the more laborious method of separately recording the waveform of the voltage to ground at each point, and then subtracting the two curves point-by-point. Here is a more direct solution:

If the ground side of the oscilloscope is connected to a common ground-point of the circuit under study, and the x-axis and y-axis inputs connected respectively to the two points of interest, a plot is obtained of the voltage at one point, designated for convenience as e_1, as a function of the voltage at the other point, e_2.

If the horizontal and vertical amplifiers are adjusted for equal deflection-sensitivity, a straight line with a slope of 45 degrees is the focus of points $x = y$, or $x - y = 0$. Then the distance from any point (x_1, y_1) to the line $x = y$ is $(y_1 - x_1)/\sqrt{2}$ — i.e., $e_1 - e_2$ times a scale factor $K/\sqrt{2}$.

If, therefore, the horizontal axis of the oscilloscope calibration screen is rotated 45 degrees to coincide with the line $e_1 = e_2$, the potential difference may be read directly as the distance from a point on the curve to the new axis.

The scale factor may be applied directly, or may be readily included in the initial calibration by rotating the screen prior to application of the calibrating voltages, setting the amplitudes as in Fig. 1. Note that the plot obtained is not of voltage difference as a function of time, but of voltage difference as a function of voltage. If a d-c. potential difference is present, it must be added algebraically to that obtained from the oscilloscope, unless the oscilloscope amplifiers are d-c. amplifiers.

If it is desired to adjust for unequal deflection sensitivities, the more general equation of the line is used, giving $(Be_1 - Ae_2)/\sqrt{A^2 + B^2}$ for the deflection referred to the new axis, which is no longer 45 degrees, but is $\tan^{-1} B/A$. Again the scale factor may be included in the initial calibration by rotating the screen to the new position, adjusting the amplitudes as in Fig. 2.

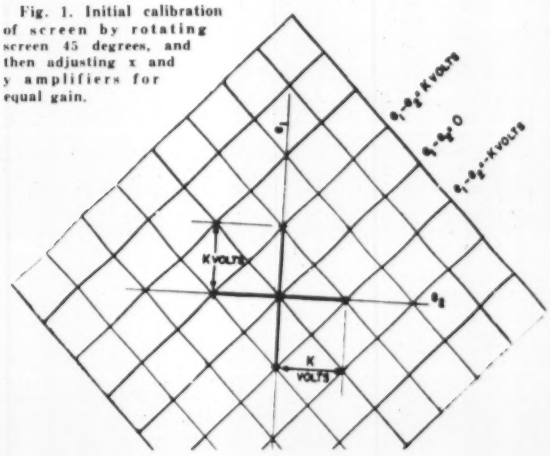


Fig. 1. Initial calibration of screen by rotating screen 45 degrees, and then adjusting x and y amplifiers for equal gain.

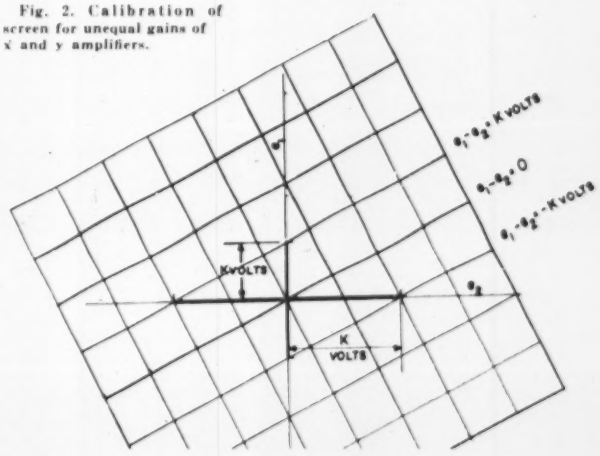
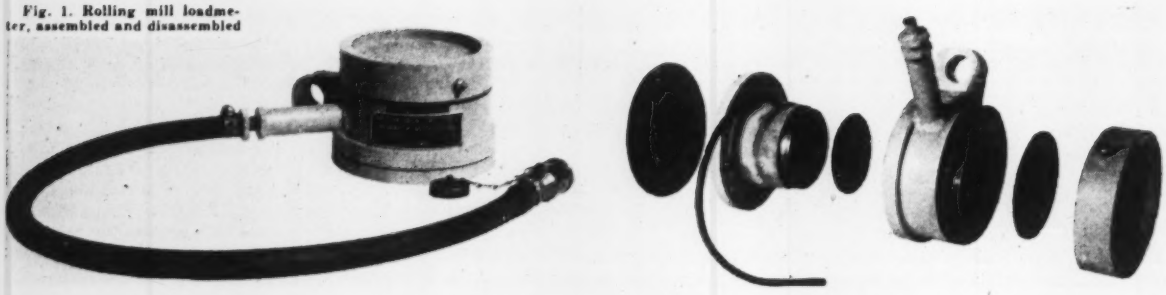


Fig. 2. Calibration of screen for unequal gains of x and y amplifiers.

Fig. 1. Rolling mill loadmeter, assembled and disassembled



A ROLLING-MILL LOADMETER

A newly developed load cylinder, positioned under the mill screws, provides continuous measurement of the load applied to the rolls of a strip mill.

By S. S. CARLISLE and R. B. SIMS
British Iron & Steel Research Association

CONTINUOUS measurement of the load applied to the work rolls of a strip mill provides information of great value in increasing productivity. The rolls must be pressed together before the strip is entered in order to take up the mill spring. If the rolls are unequally loaded the material leaves the mill with longitudinal curvature; correcting this condition empirically loses mill time and production. The efficiency of the mill can be checked by comparing the total load on the rolls with the maximum designed load. Further, overloading that frequently causes damage can be avoided. Many attempts have been made in the past to produce a loadmeter using load detectors such as extensometers on the mill housings[1], the pressure developed in hydraulic cylinders, the piezoelectrical effect[2], and electro-magnetic methods. Douglas and Ford[3] have discussed the difficulties of installing these loadmeters in industrial mills.

A loadmeter was required which would (1) not increase the mill spring materially, (2) give an accurate measure of the load independent of temperature changes, and (3) be sufficiently robust to withstand the severe conditions in production mills.

The design finally adopted was essentially a solid cylinder of steel placed between the loading screw and the top roll bearing. A measure of the load applied to it was obtained from the output of an unbalanced, temperature-compensated Wheatstone network of resistance strain gages bonded to the surface of the cylinder.

The accuracy of the load measurement depends on the ratio of the over-all height of the instrument to the diameter of the strain-sensitive cylinder; a decrease in this ratio increases the errors due to non-uniform compression. The present instrument uses 8 strain gages, representing a compromise between the permissible level of error and the limitations in height set by mill design.

Two loadmeters, each of 50-ton capacity, have been in use for over 5 years on the British Iron and Steel Research Association 10-inch x 10-inch 2-high experimental mill at Sheffield University; 2 instruments have operated in a 4-stand tandem cold mill under production conditions during the past 16 months. The basic circuit can be re-designed for use in tension, as for a load indicator for a crane.

Presented by J. V. Sturtevant, Society for Quality Control, at the 1953 Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, Pa.

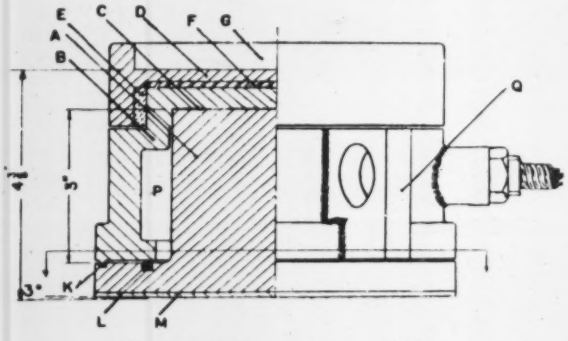


Fig. 2. Loadmeter construction details.

MECHANICAL DESIGN

A loadmeter of 300-ton capacity is shown in Figs. 1 and 2. The solid cylinder, A, is integral with the base of the instrument and is a forging which is subsequently treated to produce a yield stress not less than 34 tons/sq. in. The protecting cover, B, is machined from heat treated steel of the same quality and is a sliding fit on the cylinder. Between the cover and the cylinder top is a thin friction disc, C. On earlier models without this pad the cover tended to slip on the cylinder during loading giving a random error in calibration. On the top of the cover is a pad, D, to carry both radial and thrust loads from the mill screw.

The thrust load is taken on a graphite and grease lubricated pad, F, of laminated plastic bonded with a thermosetting resin which has an ultimate yield strength in compression of 20 tons/sq. in. Four socket screws, J, around the base hold the cover to the cylinder, and two jack screws lift the cap to give access to the cylinder and gages. They do not restrain the movement of the cap when load is applied. A rubber seal, K, protects the screws and, with the inner seal, L, provides the first protection for the gages. The loadmeters are prevented from rotating under load with the mill screw by a seating in the top of the chock.

RESISTANCE STRAIN GAGES

The arrangement of the strain gages on the stressed cylinder is shown in Fig. 3. When the cylinder is loaded,

the gages parallel to the axis of the cylinder (Nos. 1, 3, 5 and 7) undergo compressive strain and decrease in resistance; the gages normal to the axis (Nos. 2, 4, 6 and 8) increase in resistance due to the hoop tensile strains developed as the cylinder dilates. Gages are connected in series to form the arms of a Wheatstone bridge (Fig. 4).

Gage Bond

The adhesive used to bond the gages to the cylinder depends on the use. Nitrocellulose base is suitable only for temperatures below 20 deg. C., but is easy to apply. Thermosetting resins may be used up to 70 deg. C., but may need curing at temperatures above 180 deg. C., the charring temperature of the gauges. Araldite 15, a thermosetting resin, has been used whenever possible because it cures at 170 deg. C., has a relatively high fatigue strength in shear, and provides electrical resistance between gages and cylinder.

The resistance provided by the adhesive between the gages and the metal cylinder should not fall below 100 megohms for the whole network. Bowler[4] has shown that the insulation resistance of Durofix and thermosetting resins (such as Bakelite and Araldite) varies in a complex manner when used as adhesives for strain gages. At temperatures below 20 deg. C. immediately after curing the resistance is above 800 megohms, but falls to a few megohms as the temperature is increased to 95 deg. C. The variation of resistance with temperature differs for each adhesive, depending on whether the temperature is rising or falling—that is, there is considerable hysteresis, and after a few such cyclic changes the insulation resistance at any temperature suffers a permanent decrease. The temperature vs. insulation-resistance characteristics of Araldite are markedly superior to the nitrocellulose types.

To protect the strain gages from water and vapor a wide strip of rubber is wrapped round the cylinder over the gages and bonded to the metal. The rubber-covered lead wires to the gages are bonded into this seal.

Measurement of Load

Either a null or an out-of-balance method can be used to measure load. The out-of-balance method has been chosen because of circuit simplicity, speed of measurement, and lower cost. The bridge network is energized from an A.C. or D.C. supply; either indicating meters or potentiometric balancing systems can be used for the display.

Calibration

The loadmeters are usually calibrated in a testing machine, but the relationship between load and output may be derived for the simple case of uniaxial compression. The load, F, applied to the instrument is assumed to be parallel to the axis and distributed uniformly over it.

Compressive strain (E) in the cylinder causes a resistance change (δR) in the gages. If ν is the strain-gage constant, for the vertical gages:

$$\delta R/R = \nu E$$

For the horizontal gages

$$\delta R/R = \nu \lambda E$$

where λ is Paisson's ratio.

The open-circuit emf. output is

$$V_m = V_n \nu F (1 + \lambda)/2\pi a^2$$

where V_n is the voltage applied to the bridge and F is the modulus of rigidity of the material. Of course the meter current (I_m) is $V_m/(2R + R_m)$, where R_m is the meter resistance.

Both voltage and current calibrations are linear with load. The current calibration varies slightly with temperature due to changes in the gage resistances R. The potential calibration however, is independent of temperature.

Direct calibrations between smooth lubricated platens up to maximum load confirm these linear relationships. In one calibration of a loadmeter of 300 tons capacity, the meter current is 0.1454 microampere per ton load with an accuracy of ± 0.3 percent. The calculated value, using $\nu = 2.22$, $a = 2.0$ inches, $R = 2435 \pm 2$ ohms, $\lambda = 0.285$, and $E = 30 \times 10^6$ lb./m^2 is $I = 0.145$ microampere/ton.

A simple theoretical treatment is not possible when the load is not distributed uniformly over the instrument. However, two cases have been examined theoretically, using a load applied eccentrically to the cylinder.

If the cylinder is long in comparison with its diameter, the output is, from St. Venant's principle, independent of the form of loading. As it is not posible to design a loadmeter like this, the ratio of the effective height to the diameter of the cylinder is important in the calibration.

Effect of Temperature

Correction for the temperature variation between gages has been made negligible by mounting all 8 gages on the same cylinder; changes in temperature affect the gages equally because the thermal capacity of the cylinder is large and the gages are sheltered from draughts by the massive cover.

Temperature	*emf. across galvo terminals*	*Temperature coefficient*
°C.	volts	microamps/deg. C.
15	708×10^{-5}	
44	705	1.4×10^{-4}
73	696	4.2×10^{-4}

An experimental determination of the change of current calibration with temperature was made with a 300-ton capacity loadmeter at 50 tons loading. The applied bridge voltage was 100 ± 0.2 volts; the meter resistance R_m was 967.0 ohms. The table gives the results.

The experimental temperature coefficients (1.4×10^{-4} and 4.2×10^{-4}) are to be compared with the values of 1.0×10^{-4} and 3.9×10^{-4} obtained from Jones'[5] experiments.

Fig. 3. Arrangement of strain gages on cylinder.

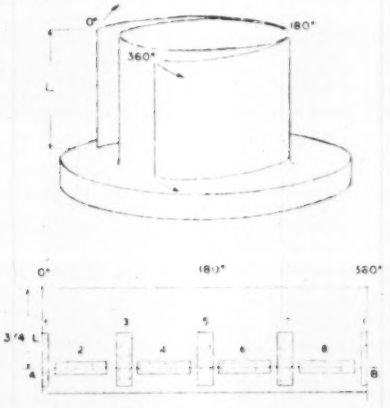
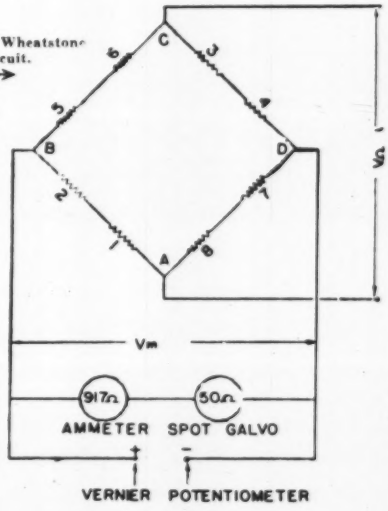


Fig. 4. Wheatstone bridge circuit.



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2. Siebel, E. and W. Ineg. Mitteilungen Kaiser Wilhelm Institut fuer Eisenforshungen, Vol. 15, 1933, pp. 1-14.

3. Douglas, A. L. M. and H. Ford, Iron & Steel Institute Special Report No. 54, Section 4, pp. 97-123.

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5. Jones, K., *The Measurement of Stress and Strain in Solids*, 1948, p. 20.

Control of Chemical Processes

This final installment presents basic plant requirements, together with suggestions for setting up controller on the plant. The entire series is being made available in book form.

by
A. J. YOUNG

SETTING UP A CONTROLLER ON THE PLANT

In Chapter IV, theoretical considerations with regard to the control characteristics of plant and controllers were discussed with the object of giving a basic understanding of the fundamental principles involved in matching controller characteristics to plant characteristics. An instrument was also described, which can be used to obtain plant data from which can be drawn a diagram to show the frequency response of the plant.

It was shown how this diagram can be used to find the control characteristics of the plant and facilitate matching the controller to them to give optimum control quality.

It was not anticipated that this technique would be used generally for setting up, or selecting, controllers. The necessary analyzers are not available to most plants and it has in any event been found that, in most applications, actual analysis of the plant is not necessary for this purpose. (It is, however, desirable that as many plant analyses as possible should be carried out, in order to build up knowledge of plant characteristics for further work in this field.)

It was hoped that the discussion would stimulate interest in a fundamental approach to the whole problem and at the same time supply the mental tools for tackling specific difficulties. Experience has shown that a knowledge of the general theory and an appreciation of the factors determining plant characteristics make the setting up (and selection) of controllers a much more rapid process and moreover a much easier matter for those without a long experience of process control. With a good working knowledge of the plant and a sound grasp of the significance of the two kinds of lags and their dependence on their distribution in the plant, it should be possible to set up a controller quickly and successfully in most applications normally encountered.

This does not mean that the use of the analyzer is confined to the infrequent very difficult problem. It may be remembered that, in the first chapter, the importance was emphasized of designing plants specifically for automatic control. It was also stated that the present knowledge of plant characteristics was not sufficient to supply the plant design engineer with adequate data for this purpose.

The function of the analyzer is to assist in obtaining these data with all possible speed. Some progress has already been made, but it will be some time before a clear picture of any but the general requirements can be presented to the designer of a particular plant.

Meanwhile, the plant chemist or engineer will probably find the following suggestions useful for setting up controllers on the plant. They should be interpreted and applied in the light of the theoretical background which has been supplied.

Consideration of plant control requirements

The first matter to consider is the requirements which the control system is expected to meet. In most practical instances some degree of compromise must be made, so that the desired quality of control can be achieved economically. In general, one of the following will be required:

(a) minimum deviation following a disturbance;

(b) minimum time interval before return to desired value, after a disturbance;

or (c) minimum offset due to changes in operating conditions.

The difficulty of providing these requirements will of course depend not only on the plant but on the nature of the disturbances anticipated. The relative importance of (a), (b) and (c) will depend on the nature of the process and the products. For example, a process which is strongly exothermic may commence to "run away," with serious consequences, if the temperature is allowed to rise only a few degrees momentarily. In another process, occasional rapid fluctuations in temperature may not be important while a small sustained temperature change may completely ruin the product. In this case a quick return to desired value is essential and offset must be eliminated as far as possible.

In some applications proportional action alone will be adequate, because the proportional band width can be made sufficiently narrow to make offset negligible and the proportional control factor (μ) will be sufficiently great to maintain small deviations with quick return to desired value. In general, however, it is necessary to employ derivative action in addition if (a) and (b) are critical requirements.

If with proportional action alone, or with derivative action, the band width is wide enough to permit considerable offset—and when (c) is of primary importance—then integral action must be employed. It must be repeated, however, that integral action is disadvantageous to the control system in all other respects and it should therefore only be used when it is really necessary.

Consideration of the plant characteristics

The two important matters are the anticipated changes in operating conditions and the lags in the control loop.

If supply and demand changes are expected to be small and disturbances slow, proportional action alone may suffice, and integral action will be almost certainly unnecessary. Rapid, transitory changes will call for derivative action.

The lags in the control loop must be estimated and their number, relative magnitudes and distribution (with respect to the detecting element) must be assessed. It is also necessary to know whether the lags are of the transmission or distance-velocity type.

Distance-velocity lags must if possible be reduced; derivative action cannot be used to counteract their effect on control. Often a straightforward rearrangement of plant, or detecting element, can be made to reduce these lags, especially when the plant is being designed.

Most plants possess predominantly transfer lags. These are most troublesome, for a given "total lag," when they are all of the same order of magnitude; the most favorable situation occurs when one lag is very much larger than all the others. A number of quite small lags can have a very bad effect on control quality.

On an existing plant the only lags which it may be possible to reduce are those associated with the measuring system itself and with the transmission of signals to and from the controller. Detecting-element transfer lag is generally most serious in temperature measurement and it should be reduced by any means possible. Lag in pneumatic transmission

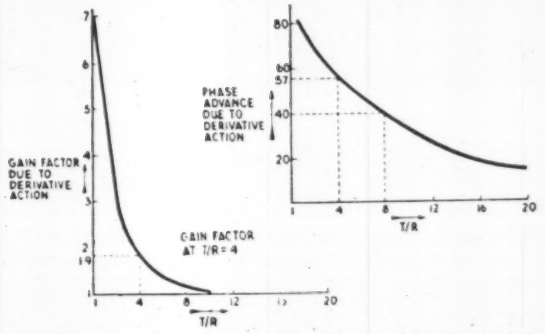

Fig. 12-1. Gain factor (left) and phase advance (right) due to derivative action.

can be reduced, where long lines make this necessary, by using transmitters or boosters. Systems employing large diaphragm-operated regulating units, especially when these are at the end of long air lines, will repay attention in this respect.

It is important to remember that lags increase in importance as they occur nearer the detecting element.

If the unavoidable lags remain considerable, and especially if they are all of the same order and numerous, the proportional band width must be wide. Derivative or integral action, or both, will be necessary, depending on the requirements and anticipated operation conditions.

Suggestions for Setting up the Controller

The considerations outlined in the previous chapters may lead to a fairly clear indication of the controller characteristics needed in a given application, but in many instances the following procedure will be found useful.

It is assumed that a three-action controller is available and that it has been checked and adjusted according to the maker's instructions. If it is found necessary to use only proportional action, or proportional plus either integral or derivative alone, a simpler controller can be substituted later if any economy can thus be made.

(1) Find the optimum proportional band width for proportional action alone. Commence with a wide band and narrow it until continuous hunting is obtained. Then widen the band until a subsidence ratio of about 3 is obtained.

(2) Read the proportional band width (say x percent). This determines the maximum amount of offset which can occur, i.e., $(x/2)$ percent of full scale range. If this offset is too great, decide whether addition of derivative action can be expected to reduce the band width sufficiently. If the band width requires a decrease of about 1/3, derivative action should be tried.

(3) If the proportional-action test shows that deviations of the controlled condition due to plant disturbances are too great, or if the period is too long, derivative action must certainly be added.

It may be permissible to emphasize once more that the purpose of derivative action is to introduce phase advance into the controller and so allow the control loop to operate at a shorter period. At the same time, it allows the use of a narrower band width.

As has been seen previously, there is a limit to the amount of phase advance which can be utilized in this way, because of the increasing gain introduced by derivative action as the action time is increased relative to the plant period.

In Fig. 12-1, it can be seen that the phase advance at $T/R = 10$ is appreciable, while the additional gain is negligible.

Hence the next step is to set $R = T/10$. The period will be shorter with derivative action and it can be estimated fairly safely as being about 4/5 of the natural period. Therefore observe the natural period T_N and set $R = (1/10)\ [(4/5)\ T_N]$.

(4) With this setting for R, narrow the proportional band to find the new band width which gives a subsidence ratio of 3.

(5) If the reduction in band width is still insufficient, the period still too long, or the control of disturbances inadequate, the value of R can be increased. The shape of the curves in Fig. 12-1, however, show that the extra gain introduced becomes increasingly large. In practice, values of T/R greater than 4 are rarely found to bring any advantage.

(6) It should be noted that the operating period will continue to be reduced by decreasing T/R (and so increasing phase gain). Hence, if period is the chief criterion, T/R can be made considerably higher with advantage than if narrow proportional band width and control of deviations are the first requirements.

7) If offset is still too large, i.e., if μ is too small, integral action must be used.

When used without derivative action, the optimum setting is normally S = plant period (T_1). T_1 must, of course, be estimated before S can be set equal to T_1. As a guide, T_1 will be longer than T_N by a factor of 1.1 to 1.3 in many applications.

Adjust the proportional band to give the 3:1 subsidence ratio. Although the band width may have increased by 50 percent, offset will be eliminated. In other respects, control will of course be worse owing to the decrease in value of μ.

(8) If, as a result of using proportional plus integral action alone, deviations and period are too great, derivative action must then be used as well.

(9) It is not possible to give *general* quantitative suggestions for setting up a three-action controller, because each has a different interaction factor. This implies also a different optimum ratio for derivative to integral action time. Several makers approach the problem by linking the action settings so that this optimum ratio is achieved. Unless this is done, it is only possible to approach the problem logically by obtaining the necessary information from the maker. It is not given in all makers' instruction manuals.

A safe rule, however, is that integral action time must be equal to or less than the *operating* period; otherwise it will have too little effect to be useful. At the same time, as much derivative should be added as is required to reduce overshoot and period to satisfactory values. The general aim is always to reduce the proportional band width as much as possible, bearing in mind the influence of the interaction factor; i.e., proportional band width setting divided by interaction factor equals effective proportional band width.

It must be remembered that if derivative action is added to a controller already matched to the plant with proportional plus integral action only, then the effective integral action time will be increased above the nominal value set on the dial. The factor by which the integral action time is increased by the addition of derivative action will be equal to the interaction factor.

In such circumstances, therefore, the integral action time setting should be decreased, so that the effective time remains equal to or less than the operating period when the derivative action is added.

The above suggestions apply to continuous processes which run at a constant desired value. Batch process control requires separate treatment, which cannot be given here. It may, however, be useful to point out that, if integral control is employed on a thermal batch process, overshoot is bound to occur when the batch is initially brought up to temperature.

Unfortunately, the amount of offset which can be tolerated without damage to the product is often so small that integral action must be employed, and at the same time little or no overshoot can be allowed. In such circumstances, it is strongly advised that the instrument maker should be given full data on the problem and asked for advice to obtain the operation of his control equipment in the particular application.

CONCLUSION

It is hoped that the information contained in this serial will assist in spreading a knowledge of the principles upon which the application of process control is based; and that this general treatment of the subject will be found useful in the study of particular control problems and installations.

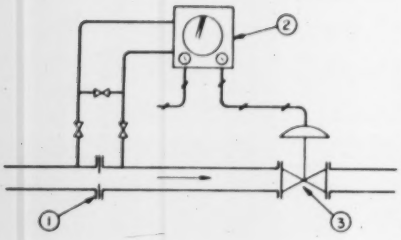

Fig. 1. Basic flow-control system.

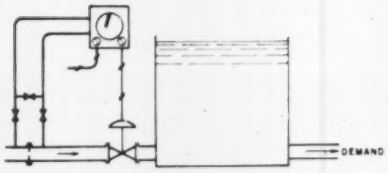

Fig. 2. System with added capacity.

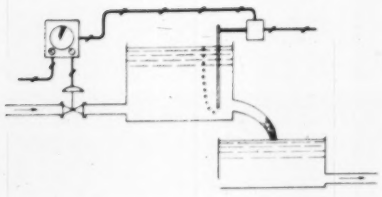

Fig. 3. Flow control from level measurement.

Control-system Design

by S. L. RANSON
CDC Control Services, Inc.

IN water- and waste-treatment fields, it is frequently the practice simply to make manual adjustments of feed rates of treatment chemicals in accordance with periodic flow readings. Such practice does not use the devices currently available for measurement and control of variables such as pH, conductivity, and oxidation-reduction potential.

Flow Control Principles

Consider a raw water stream that is to be treated with lime for pH adjustment to establish optimum coagulation conditions. With constant water-flow rate the quantity of lime to be added depends only on pH value. Where the character of the water varies widely, flow control should be used. A basic control system (Fig. 1) consists of a flow-rate sensing device, a measuring and controlling mechanism, and a control valve.

The *flow-sensing device* can be an orifice, a Venturi, a variable-area meter, or simply an elbow in the line. The automatic controller can be electric, hydraulic, or pneumatic.

Controller response can be on-off (two-position) or proportional; the latter is used most commonly.

Inverse Derivate Response

Flow control can be one of the most difficult of all control problems, principally because flow processes usually have short time-constants—that is, changes occur faster than corrections can be applied by the controller. In low-capacity systems, changes in demand are felt instantly at the flowmeter. Generally, when instability or sustained upset occurs in the system, the proportional-band setting of the controller is widened, and when stability is regained the proportional band is narrowed to its original value. This can be accomplished manually or by an automatic circuit which, in effect, momentarily widens the band and then returns to the narrow setting. This controller response is a form of rate action known as *inverse derivative*. The response desensitizes the control to prevent a cycling while the upset settles of its own accord.

Process Characteristics

Changes in process equipment often can improve control. When lack of capacity in the system is partly responsible for instability, capacity can be added to the process (Fig. 2). When this is done, changes in demand do not give immediate change in flow. This builds controllability into the process by addition of self-regulation.

The system with added capacity could be controlled from the level in the capacity chamber instead of by direct flow measurement (Fig. 3). This provides some simplification of control—a simple bubbler or static-head instrument can be used instead of an orifice or Venturi meter. Also, we now have a linear device instead of a square-root flowmeter.

Presented at Conference on Instrumentation In Water, Sewage and Industrial Waste Treatment, May 14, 1953, Manhattan College, N. Y.

Analysis Techniques

Once the degree or exactness of control required has been established, the problem of designing a suitable control system can be approached in one of two ways—empirical or analytical. We might also call these the artistic and the scientific methods. The first implies reliance on experience plus "feel" for such problems. Some designers possess these qualifications and produce amazing results, but too often the solution is obtained by inefficient trial-and-error. The analytical method, rapidly gaining favor, is becoming more necessary as control problems increase in complexity.

Several methods of scientific analysis of control systems have been advanced in the past. The method of Ziegler and Nichols consists of plotting change in flow (or other variable) versus change in valve position. The curve obtained (Fig. 4) is called the *reaction curve*. The slope of the line drawn tangent at the point of inflection of the curve is called the *reaction rate* of the system. The point at which this tangent line intersects the time scale represents the *lag* of the controlled system. From this information, controller response settings can be predicted using empirical equations. If it is impractical to obtain the reaction curve by upsetting the process, the curve sometimes can be calculated from design data.

Analysis by Analog Computer

A more accurate and versatile method of analysis is use of an analog computer. Analytical representation of a system requires determination of the transfer functions of the controller and process. Once this representation is obtained, the complete system can be simulated on the computer; this produces an electrical analog of the hydraulic, pneumatic, or mechanical system. It then is possible to vary operating conditions, to create disturbances of any type, to obtain visual evidence of the effect of upsets, to determine the effect of varying the control system parameters, and to arrive at optimum controller settings. It also is possible to determine the effect of altering control or process components—for example, addition of capacity; such information is particularly useful in the design stage.

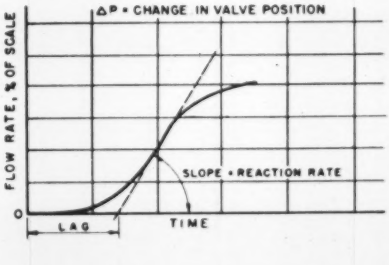

Fig. 4. Process reaction curve.

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

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SPECIFIC GRAVITY OF GASES

This important résumé presents six basic methods for measuring specific gravity of gases, including principle, technique, accuracy, and operational considerations. Two techniques (direct weighing and gas balance) are basic; the other four (effusion, viscous drag, kinetic pressure increase, and air-column weighing) must be calibrated against gases of known specific gravity.

by BLAIR J. WILLARD
The Texas Company

SPECIFIC GRAVITY of a gas is defined as the ratio of the weight of a given volume of gas at standard conditions to the weight of an equal volume of pure air at standard conditions.

Of the many variables which affect the flow of gas through an orifice, the specific gravity of the gas is one of the most important. As a gas increases in specific gravity it encounters a greater resistance when it flows through an orifice; conversely, a decrease in specific gravity enables the gas to conform more easily to the restriction in its passage. Thus it may be inferred that the flow rate through an orifice is inversely proportional to its specific gravity. Therefore, where the measurement of gas flow by orifice meters is concerned, there is a vital need for accurate determination of specific gravity of gases.

The common methods employed by the oil and gas industry for determining specific gravity of gases are (1) direct-weighing method, (2) gas-balance method; (3) effusion method, (4) viscous-drag method, (5) kinetic-pressure-increase method, and (6) air-column-weighing method.

1. Direct-weighing Method

The direct-weighing method is considered the basic method which requires no calibration against other specific-gravity instruments. The principle involved is fundamental—it is based on the comparison of the weight of a volume of gas against that of air under the same temperature and pressure conditions. As this method is lengthy and exacting, it is classified as a laboratory method and is not considered practical for routine testing in the field.

Two globes fitted with ground-glass stopcocks are used. The globes are as much alike in size, shape, and weight as possible. One globe is used as a counterweight; the other globe (the "weighing globe") contains the gas to be weighed.

Weighing Sample Gas and Globe

Preliminary work consists of determining the weight of the weighing globe when evacuated. As it is impossible to obtain two globes of exactly equal weight, one globe will not quite counterbalance the other on the analytical balance. The heavier of the two globes is selected as the weighing globe and is evacuated and placed on the balance, with the other evacuated globe as a counterweight. The difference in weight in the two globes (the amount of weight which must be added to he counter-balance globe) is used as the weight of the weighing globe. After the weight of the weighing globe has been determined, the globe is filled with the gas sample until the pressure in the globe is as close as possible to atmospheric pressure. Fig. 1 depicts one method for introducing the gas sample. The weighing globe (containing the gas sample) then is allowed to reach temperature equilibrium, at which time the room temperature and the pressure within the globe are recorded. Finally, the weighing globe is weighed and the total weight of sample and globe is recorded.

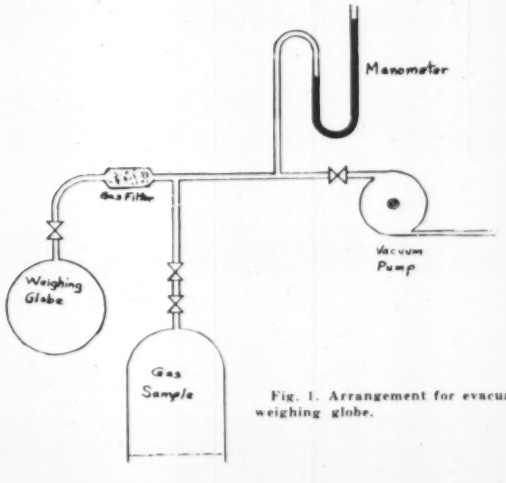


Fig. 1. Arrangement for evacuating and filling weighing globe.

Comparison Against Air

Now, in order to compare the gas with air, the same weighing globe is evacuated and filled with pure air in the same manner as with the gas. After

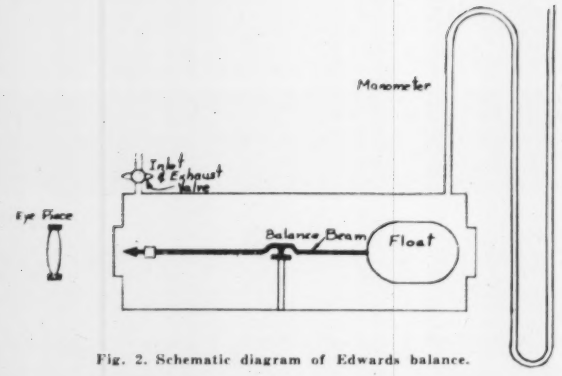


Fig. 2. Schematic diagram of Edwards balance.

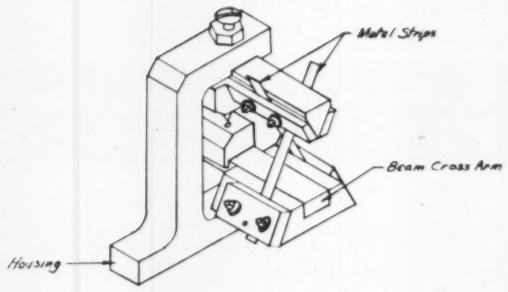


Fig. 3. Ac-Me balance-beam support.

the air sample reaches temperature equilibrium, its pressure within the globe is recorded. The same room temperature is used for both weighings. Then, the weighing globe is again weighed on the analyfical balance and the total weight of air sample and globe is recorded.

Calculations

By definition, *specific gravity = wt. of gas at standard conditions divided by wt. of air at standard conditions.*

Example:

Net weight of gas in weighing globe (W_g): 0.250 gm.
Net wt. of air in weighing globe (W_a): 0.357 gm.
Abs. press. of air in weighing globe (P_a): 505.0 mm.
Abs. press. of gas in weighing globe (P_g): 500.0 mm.
Abs. temp. of gas in weighing globe (T_g): 580 deg. R.
Abs. temp. of air in weighing globe (T_a): 582 deg. R.
Specific Gravity = $(W_g \times P_a \times T_g) / (W_a \times P_g \times T_a) = (0.250 \times 505 \times 580) / (0.357 \times 500 \times 582) = 0.705$

As the pressure readings are all taken at the same temperature it is unnecessary to correct pressure readings to standard temperature conditions.

Accuracy

The accuracy of this method depends mainly on the sensitivity of the analytical balance, and to some extent on the type of gas being tested and the deviation from Boyle's law at the temperature and pressure of the test.

2. Gas-balance Method

For the accurate determination of specific gravity of gases above or below atmospheric pressure, the Edwards balance may be used. This apparatus requires the use of only a small sample of gas and combines speed and accuracy.

Furthermore, no preliminary calibration of the apparatus is necessary. However, the apparatus is not usually portable, owing to its delicate construction. Hence it is commonly used only in the laboratory.

Operation of this apparatus is based on Archimedes' principle, which states that the weight of a given volume of a substance immersed in a liquid or gas is equal to the weight of the fluid or gas displaced. Also, according to Boyle's law, the density of a gas is directly proportional to its pressure. As density is, by definition, the weight per unit volume, and as the weight of displaced fluid or gas is called "buoyancy," it can be stated that buoyancy is directly proportional to the exerted pressure on the gas.

Essentially, the Edwards balance is a scale-balanced displacer enclosed in a chamber (Fig. 2). Air or gas is introduced in the chamber at sufficient pressure to balance the float. By using the same relationship between the pressure of air and gas as is used in the calculations involving weight of air and gas, the specific gravity of the gas sample can be determined readily.

Procedure

The test procedure consists of first evacuating the chamber and then admitting pure air at sufficient pressure to move the float indicator to the marked balancing position; the pressure is recorded. The next step involves evacuating the float chamber and admitting gas to be tested at sufficient pressure to move the float indicator to the marked balancing position; this pressure is recorded. Manometer and barometer readings are recorded to the nearest 0.5 mm. of mercury.

The air readings are repeated until three consecutive readings give air values within 2 mm. absolute. In the event that the gas to be tested contains condensible material, the sample should be heated in its container to insure that all constituents are in the vapor phase.

The chamber temperature should not vary more than 1 deg. Fahrenheit between the air and gas readings.

Calculations

The manometer readings of the air or gas sample in the float chamber are converted from relative-pressure to absolute-pressure readings by adding to (or subtracting from) the barometric-pressure readings—if the relative pressure reading is less than atmospheric pressure, the relative pressure is subtracted from the barometric pressure; if the relative pressure is greater than atmospheric pressure, it is added to the barometric pressure.

Specific Gravity then equals the (barometric pressure ± manometer press. for air) divided by the (barometric pressure ± manometer press. for gas).

In ordinary industrial determination of specific gravity, it is not considered necessary to apply any temperature corrections to the barometer and manometer readings. It has been found that the maximum error caused by omitting temperature corrections is seldom as high as 0.001. Where the scales of both the barometer and manometer are of the same material calibrated at the same temperature, no temperature corrections are required in even the most exacting tests.

Example

Barometer press. reading: 759.0 mm. Hg
Manometer reading for air: 259.0 mm. vacuum
Manometer reading for gas: 41.0 mm. pressure
Absolute air-balancing press. = 759.0 − 259.0 = 500.0 mm.
Absolute gas-balancing press. = 759.0 + 41.0 = 800.0 mm.
Sp. Gr. = Air-balancing pressure / gas balancing pressure = 500.0 / 800.0 = 0.625

Accuracy

Careful operation gives results agreeing within 0.003 specific gravity. Results should be reproducible with different operators and different instruments under similar conditions. The accuracy of the method depends primarily on balance sensitivity and chamber temperature variations.

Ac-Me Suspension-type Balance

This instrument uses the same gas-balancing principle as the Edwards-

July Meeting: Thursday, the 15th, Rio Hondo Country Club, Downey, Calif.

Feature: Robert Galley, North American Aviation Corp., will give a paper on "Trends in Flow Measurement Techniques."

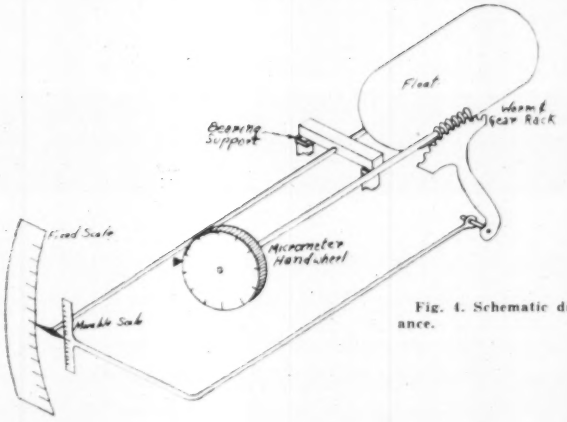


Fig. 4. Schematic diagram of Anubis gas balance.

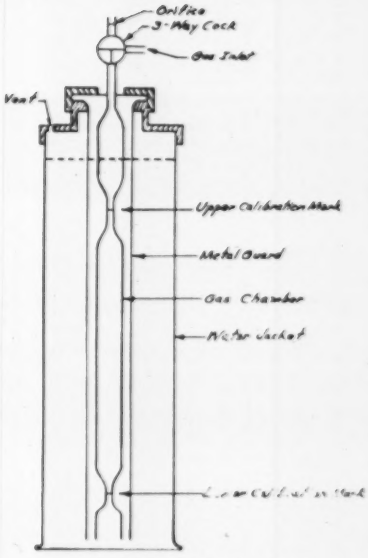


Fig. 5. Schillings bottle.

type balance. The instrument is rather large in size and requires more gas to operate it than is used in the Edwards balance. For this reason its use in the laboratory may be somewhat limited.

A locking device in the instrument permits it to be transported without removal of the beam and without damaging or producing any change in the position of the beam support. No water jacket is utilized to stabilize chamber temperature.

One of the unique design features of the Ac-Me balance is the means by which the balance beam is pivoted or suspended. Fig. 3 shows the suspension arrangement at one end of the cross arm. The beam is suspended from its cross arm on both sides by two pairs of phosphor-bronze metal strips. These strips are so thin that the energy required to flex them is negligible.

Calculations.—The calculations are identical to those described for the Edwards balance.

Accuracy.—The accuracy is comparable to that of the Edwards-balance method.

Anubis Direct-reading Gas-density Balance

The Anubis instrument (Fig. 4) is a beam-type gas-density balance which is essentially an adaptation of the Edwards balance; Archimedes' principle is used. This instrument differs from the Edwards balance primarily in the direct-reading feature which allows the specific gravity to be read directly from the scale.

The beam, with the float on one end and pointer on the other end, is supported by a crossbar containing a finely machined ball-bearing at each end, which rests on smooth sapphire surfaces. A movable index is used in conjunction with the main scale, and is adjusted by means of a micrometer which provides readings to the third decimal place. The chamber enclosing the balancing mechanism is fitted with a large window through which the operator observes pointer movement along the scale and also the balancing mechanism. When the balance is not in operation, a beam release raises the beam from the sapphire surfaces.

As the beam is balanced when the chamber is filled with pure air at atmospheric pressure, when a gas lighter or heavier than air fills the chamber at atmospheric pressure, the float will fall or rise an amount proportional to the gravity of the gas. Thus, pressure or vacuum conditions in the chamber are not necessary. In the event that a gas sample exists under vacuum, the apparatus must be used as an Edwards balance and the gravity determined by relative pressures of air and gas within the chamber. Normal operation, however, is for atmospheric pressures, and determination of gravities by the Edwards method using this apparatus may be subject to error.

There are three methods which may be employed in the use of this instrument. However, only the first of these three methods is recommended as standard procedure by the California Natural Gasoline Association.

Method No. 1

The chamber and sampling connections are purged with the gas to be tested by the evacuation method. Then, with the chamber evacuated, the balance-beam locking device is released. The gas to be tested is admitted slowly until the balance beam attains a point of equilibrium opposite some part of the divisions on the main scale. The pressure in the chamber should be as near 14.73 psia. as possible.

After making another careful check of the balance level, the micrometer scale is moved until it reaches a position where the pointer swings exactly the same distance on either side of the zero point. When the correct balance point has been determined in this manner, the apparent specific-gravity is read to the nearest thousandth from the main scale and the micrometer scale. The apparent specific-gravity is converted to actual specific-gravity by the following formula:

$$G = (761.75/P) \times G' \times (T/520)$$

where G is actual specific-gravity, G' is apparent specific-gravity, P is manometer reading of gas pressure in chamber in mm. Hg. absolute at 32° F., and T is temperature of gas at balancing conditions in degrees Rankine.

Method No. 2

When the sample-gas pressure is above atmospheric pressure, the balance is first purged for 4 or 5 minutes by allowing a small flow of gas to pass from sample source through the chamber and out through the purging valve to the air.

After purging has been completed the gas inlet valve is closed; then, after a few seconds, the purging valve is closed. This traps a sample of the gas to be tested in the chamber at atmospheric pressure.

The balance is checked for level and then the balance beam is unlocked. Then, the micrometer scale is positioned and the apparent specific gravity is read in the same manner as in Method No. 1.

The calculations involved are identical with those described for Method No. 1.

Method No. 3

This method involves use of the Anubis balance as an Edwards balance; the procedure is the same as that for use of the Edwards balance.

Accuracy

Specific-gravity values obtained should be within the limits of accuracy obtainable by other acceptable commercial types of balances. Fundamentally, the accuracy depends on the accuracy of the instrument calibration and the deviation of gases being tested from Boyle's law and Charles' law under the conditions of the test.

3. Effusion Method

Although the effusion method of determining specific gravity of gases is

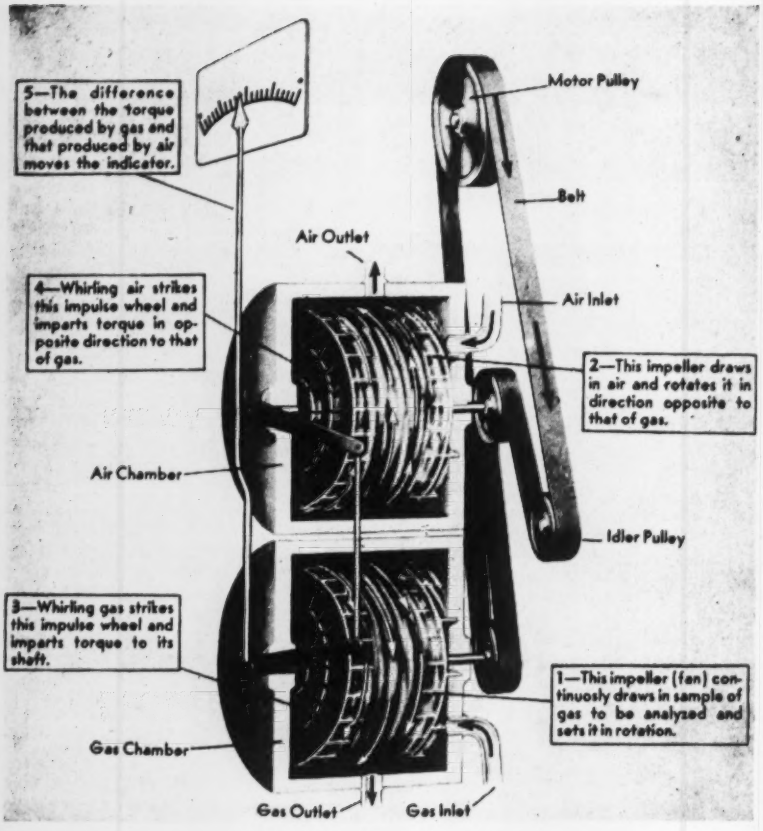

5—The difference between the torque produced by gas and that produced by air moves the indicator.
Motor Pulley
Belt
Air Outlet
4—Whirling air strikes this impulse wheel and imparts torque in opposite direction to that of gas.
Air Inlet
2—This impeller draws in air and rotates it in direction opposite to that of gas.
Air Chamber
Idler Pulley
3—Whirling gas strikes this impulse wheel and imparts torque to its shaft.
1—This impeller (fan) continuously draws in sample of gas to be analyzed and sets it in rotation.
Gas Chamber
Gas Outlet
Gas Inlet

Fig. 6. Ranarex gravitometer.

not a basic method—it must be calibrated against gases of known specific gravity—it is a simple and rapid procedure which can be performed equally well both in the laboratory and in the field. Perhaps the most commonly used apparatus for this method is the Schillings bottle.

The principle of operation is based on the precept that the rate of flow of a gas through an orifice depends on the specific gravity; a gas of high specific-gravity has a lower rate of flow through a fixed orifice than does a gas of low specific-gravity (at the same conditions).

The apparatus, (Fig. 5) is relatively simple. The Schillings bottle consists of a glass cylinder approximately 12 inches high and 3 inches in diameter. The top of this cylinder is fitted with a metal cap which contains a vent hole. The center of the cap is loosely fitted with a glass tube of small diameter, which extends to within about ½ inch from the bottom of the cylinder. The upper end of the tube terminates in a brass connection containing a three-way cock and a mounting into which various-sized orifices may be inserted.

Operation involves first filling the cylinder with water up to the upper calibration mark on the glass tube. The apparatus is then allowed to stand until temperature equilibrium with the surroundings is reached. When temperature equilibrium has been attained and the proper-size orifice is in its mounting, the test may be conducted.

With the three-way cock closed, the tube is raised completely out of the water and then lowered into its original position. This causes the tube to be filled with air. Next, the three-way cock is opened, allowing the head of water in the cylinder to force the air up and out of the tube through the orifice. As the water rising in the tube displaces the air, the time it takes for the water to rise from the bottom calibration mark to the top calibration mark is noted by use of a stop watch. This procedure is repeated until the time checks within 0.2 second.

In order to establish the gas rate and air rate under the same conditions, the gas and air determinations are run as close together as can be done. The gas-source connection is attached to the inlet connection on the three-way cock and the gas is allowed to displace the water in the tube and slowly bubble out through the water in the cylinder. This is continued for several minutes so as not only to purge the tube, but also to insure a complete saturation of the gas with the water. If the gas rate entering the Schillings bottle is too great, there is danger of spilling water from the cylinder; this would change the original water level and the gas test could not be compared with the air test. A decrease in water level would mean a decrease in liquid head with a consequent reduction in pressure on the gas to be forced through the orifice. The displacement time is recorded as with the air test. Several readings are taken and an average time is recorded.

Calculations

The apparent specific-gravity by this method is easily obtained:

Apparent Specific-gravity = (*seconds of gas time*) ^{2} / (*seconds of air time*) ^{2}

As the gas sample is saturated with water during the test, and as the gases being tested may not contain the same amount of water vapor, errors in apparent specific-gravity may develop from this cause. However, inasmuch as the possible error is usually small, common practice is to neglect it for routine field determinations. The true specific-gravity is determined by plotting the apparent specific-gravity against known specific gravities of standardized gases. These known specific gravities may be determined by Edwards balance or by some other accurate method. As no two orifices used in these instruments are exactly the same size and shape, a calibration curve must be constructed for each orifice.

Accuracy

Many variables affect the accuracy of this instrument; the method is not considered to be as exact as the gas-balance method. However, its portability, coupled with its easy and rapid operation, makes it a valuable instrument for routine field work.

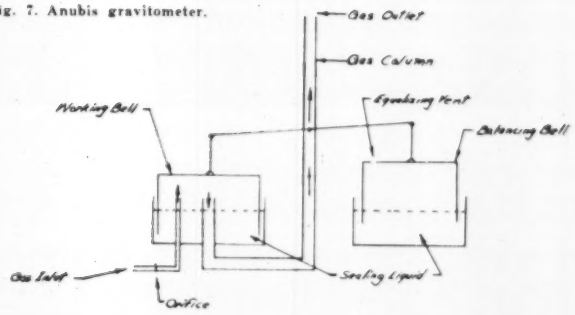
4. Viscous-drag Method

The *Ranarex gravitometer* (Fig. 6) employs the viscous-drag principle for measurement of specific gravity. By measuring the fluid friction (viscous drag) of a gas as it passes through the instrument, the specific gravity is determined. This is not a basic method because the instrument must be calibrated against gases of known specific gravity throughout its working range.

The principle is like that of the automotive fluid coupling wherein two fans are sealed in a chamber of oil. The driving action of one fan imparts its motion through the oil to the other fan and causes it to rotate. In the Ranarex instrument, the fluid medium is air and gas.

The instrument consists of two chambers, one on top of the other. The top chamber, or air chamber, contains an air inlet and outlet, a motor-driven impeller fan, and an impulse wheel. Air is directed into the chamber by the impeller fan which rotates at constant speed. This imparts a rotating motion to the air and drives it against the air impulse wheel, producing a torque on the air-impulse-wheel shaft. The lower chamber, or gas chamber, is identical to the air chamber; however, the gas impeller fan rotates in the opposite direction to the air impeller fan. Thus, a torque is produced on the gas-im-

Fig. 7. Anubis gravitometer.



pulse-wheel shaft which is opposite to that produced on the air-impulse-wheel shaft. The two impulse-wheel shafts are linked together so that the two torques are constantly opposing each other. If the gas in the gas chamber is more viscous (has a higher specific gravity) than the air in the air chamber, a greater torque exists in the gas-impulse-wheel shaft. A pointer is attached to this shaft. If a differential exists between the two torques, the pointer indicates this differential. If the gas specific-gravity and the air specific-gravity are equal, the opposing torques balance each other and no pointer movement occurs.

About six cubic feet per hour of approximately atmospheric-pressure gas are required to operate the instrument. The entering gas must not be dried or changed in any way; but the air must be dried. Before being used, the instrument must be calibrated throughout its range against gases of known specific gravity. A chart with a recording pen sometimes is incorporated in the instrument to obtain a continuous record of specific-gravity fluctuations in a gas line.

Accuracy

Owing to its rugged construction, the accuracy of the instrument is not affected greatly by vibrations or atmospheric conditions. When installed and calibrated properly, accuracy should be within 1.5 percent of the difference between the maximum and minimum specific-gravity readings on the scale.

5. Kinetic-Pressure-Increase Method

An indicating gravitometer-type instrument which utilizes the difference in pressure developed between the center of a rotating fan and the tips of the fan blades when running at a constant speed is the *Metric gravitometer*. The differential in pressure developed varies with the specific gravity of the gas.

As with the Ranarex gravitometer, this instrument must be calibrated throughout its range against gases of known specific gravity. Usually, a continuous recording device is included with the instrument.

Accuracy

Atmospheric conditions and vibration do not affect the accuracy of this instrument. Its rugged construction enables it to withstand rough usage. It has an almost instantaneous response to specific-gravity changes, and only small amounts of gas are required for its operation.

6. Air-Column-Weighing Method

This method measures the difference in buoyant force between a column of gas and that of an equal column of air. The Anubis direct-weight type of gravitometer (Fig. 7) is typical of instruments utilizing this method. These gravitometers are unique in that no external source of power is required for their operation.

When the gas being tested is introduced at approximately atmospheric pressure, the balance of the beam is upset because of the difference in weight of the column of air on top of the working bell and the weight of the column of air plus the column of gas on the under side of the bell. Thus the weight of the gas is measured. This weight difference is transmitted by mechanical linkage to a recording apparatus where it is recorded as specific gravity.

Accuracy

The delicate construction of this type of instrument requires careful handling and consideration of location. Earlier models were affected by drafts, impure air, and atmospheric conditions; however, later models contain compensating devices which adjust for the many variables which might affect its accuracy. Good results are obtained when it is calibrated properly throughout its working range, although frequent calibration may be necessary.

Conclusion

A wide variety of methods are available; each method has its merits. Consideration of which method or instrument to use depends largely on the accuracy required and the frequency of the measurements.

References

1. CNGA Bulletin TS 391, July 1939.
2. Stephens, M. M. & Spencer, O. F. Nat. Gas Eng., Vol. 3, Penn. State College, 1939.
3. Perry, J. H., *Chem. Engineer's Handbook*, McGraw-Hill, 1950.

The Model G1 transducer is a research tool designed for the measurement of forces from ± 1.5 ounces to ± 80 ounces and for the measurements of displacements to ± 0.0015 inch.

Since the moving parts of the transducer weigh but 4.3 grams, the dynamic characteristics of most systems to which it is coupled are relatively unchanged.

Force or displacement applied to the transducer probe is translated into an exact electrical equivalent by means of a complete balanced bridge of strain sensitive resistance wire.

Please request Bulletin No. 1.1.

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For more information circle **92** on inquiry card.

Briefs . . .

Instruments and AUTOMATION

Recorder-controller with Magnetic Standard

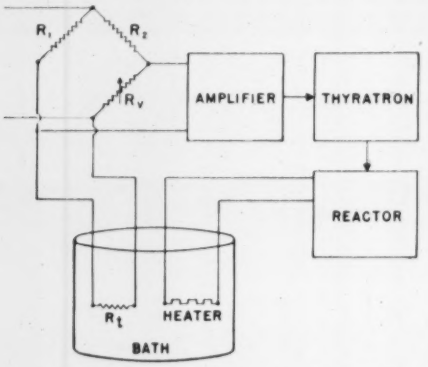
Vital center of the (new) G-E potentiometric system is the new magnetic standard. Exploiting the high stability of a permanent magnet, the magnetic standard offers (at no extra cost) an unchanging reference for truly continuous standardization, and . . . eliminates several components used in conventional recording systems—the slidewire resistor, standard chemical cell, dry-cell, standardizing mechanism, and moving contacts in both slidewire and standardizing mechanism. (*From new* 20-*page GED*-2100 *"General Electric Announces New Recording Controller," General Electric, Schenectady, N. Y.*)

For this literature circle **401** on inquiry card.

Thermistors

Thermistors are metal oxide conductors having relatively high resistances and very large negative thermal coefficients of resistance.

In comparison with metal conductors, thermistors have two outstanding advantages in laboratory instrumentation; namely, high resistance and high temperature coefficient of resistance. The higher order of resistance facilitates their



employment in bridges whose outputs require amplification, while the high temperature coefficient of resistance allows the operation of controlling devices in response to resistance changes of the thermistor with a moderate and practical degree of amplification.

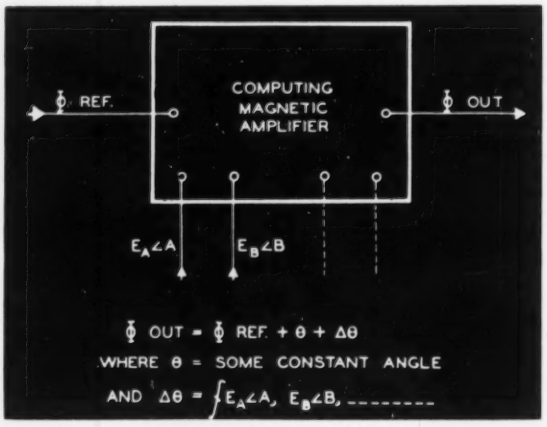
Considered as a temperature measuring element the thermistor in a simple Wheatstone bridge is able to develop a sensitivity more than ten times that obtainable with resistance thermometers in a special low resistance bridge, assuming equivalent sensitivity of the device used to indicate bridge balance; and it appears that thermistors in present production approach closely the stability and precision of platinum resistance thermometer elements.

In small baths intended for a moderate degree of regulation, it is practical to use simple mixing propellers. In the larger baths and in any case in which design is aimed at regulation in the order of 0.01 deg. C, turbine or centrifugal types of circulator are essential to produce positive patterns of distribution and recirculation. (*From new* 30-*page Vol.* 6 *No.* 1 *issue of "Apparatus and Methods," E. H. Sargent & Co., Chicago* 30, *Ill.*)

For this literature circle **402** on inquiry card.

Phase-shift Measurement

The Type 7000-A Primary Phase Standard generates two sinusoidal voltages of the same frequency whose phase angle is precisely known and continuously variable from 0



to 360 deg. with an accuracy of plus or minus 0.05 degree or better. A method has been devised whereby the Primary Phase Standard may be used with certain auxiliary equipment to measure phase shifts through a computing magnetic amplifier whose absolute phase shift is known to within plus or minus 0.4 degree. This method is described, together with certain suggested applications to other phase measuring problems. (*From new* 4-*page Lab Report No.* 8, *Technology Instrument Corp.*, 531 *Main St., Acton, Mass.*)

For this literature circle **403** on inquiry card.

Weighing Systems

The basic principle of Emery Hydraulic Weighing Systems is to convert force into hydraulic pressure, and then measure this pressure in a calibrated pressure indicator or

Pyrometer Wire Tables

Resistance tables for pyrometer wires in ohms per 100 ft. at 68 deg. F.:

(*From new* 8-*page Bulletin* 31, *Thermo Electric Co., Inc., Saddle River Twp., Rochelle Pk., N. J.*)

For this literature circle **404** on inquiry card.

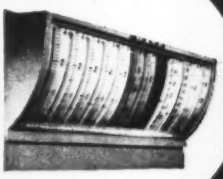
INDIVIDUAL

B & S GA.	DIAM.	CIRCULAR MILS	COPPER		IRON		CONSTANTAN		ALLOY 125		CHROMEL P		ALUMEL	
			Ohms	Ft./Lb.	Ohms	Ft. Lb.	Ohms	Ft. Lb.	Ohms	Ft. Lb.	Ohms	Ft. Lb.	Ohms	Ft. Lb.
1	2893	83690	01239	3 939	07186	4 470	3513	3 965	1613	3 943	5078	4 025	2115	4 086
2	2576	66360	01563	4 966	09067	5 637	4430	5 000	2034	4 971	6404	5 074	2667	5 151
3	2294	52620	01971	6 263	1143	7 107	5587	6 305	2566	6 270	8077	6 399	3364	6 496
4	2043	41740	02484	7 897	1441	8 961	7044	7 950	3234	7 906	1 018	8 069	4241	8 191
5	1819	33090	03134	9 962	1817	11 31	8885	10 03	4080	9 972	1 284	10 18	5349	10 33

LOOP

B & S GA.	IRON CONST.	COPPER CONST.	IRON ALLOY	CHROMEL ALUMEL
1	4232	3637	2332	7193
2	5336	4586	2940	9071
3	6730	5784	1709	1 144
4	8485	7292	4675	1 442
5	1 070	9198	5897	1 819

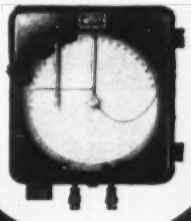
one of these Hays gages will meet your LOW PRESSURE requirements



W-Gage for large boilers and remote indication

B-Gage for small boilers, combustion testing and air filters

FOT-Gage for furnace pressure or fuel flow—air flow indication



OT-Recorder for draft or pressure

D-Gage for commercial, institutional boilers and industrial furnaces

Whether you need a draft gage for the largest steam generator, or a small portable gage for spot checking pressure conditions, first or last, it will pay you to talk to Hays, manufacturer of the most complete line of draft and low pressure gages.

Functional in styling, Hays gages have the features instrument men have always asked for—easy to read, accessible and extremely dependable.

The heart of all Hays low pressure gages is a diaphragm housed in cast metal. Diaphragms are easily replaceable in the field.

All Hays gages are guaranteed to withstand at least 100% over range without failure!

Why not talk to the people at Hays about low pressure gages for your applications—or write for complete details: *Bulletin 54-667-8.*

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY, 8, INDIANA

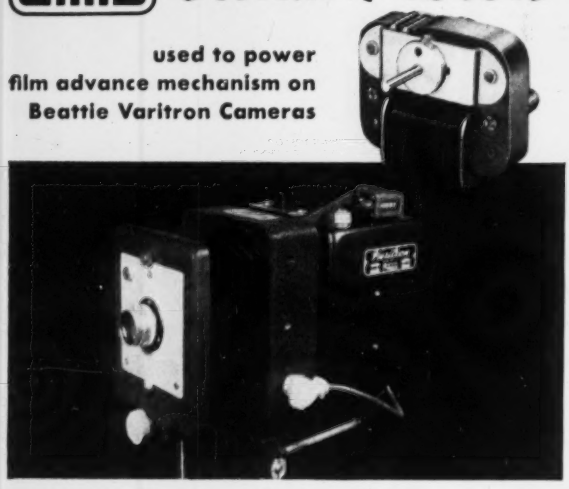
For more information circle **93** on inquiry card.

BARBER COLMAN

Barcol®

Small Motors

used to power
film advance mechanism on
Beattie Varitron Cameras



Ideal for remote photographic recording of data from meters, oscilloscopes, and similar apparatus, Beattie Varitron Cameras by Photographic Products, Inc., incorporate a Barcol type DYAB Small Motor to power the film advance mechanism. For reliable, positive actuation of your instruments, too, there's a wide line of high-torque Barcol Small Motors up to 1/30 hp. Unidirectional, reversible, and synchronous. With or without gearing . . . open or enclosed. Write for data sheets.

BARBER-COLMAN COMPANY, DEPT. F, 1215 ROCK ST., ROCKFORD, ILL.

For more information circle **94** on inquiry card.

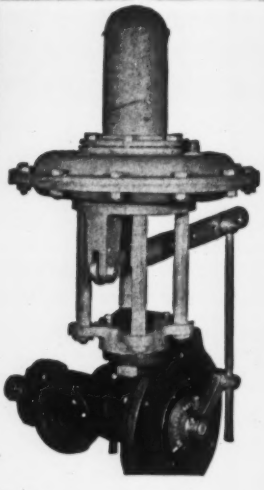
Cure for 3 Headaches!

1. Installation Problems

2. Fitting Costs

3. Engineering Time

CONOMOTOR
Pneumatic Diaphragm Motors for Operating BURNER VALVES



Available from stock. Assembled complete with any valve; North American, Hauck, Maxim-Premix, wafer-type butterfly, etc. All ovens, furnaces, kilns can be efficiently controlled by ConoMotor pneumatic diaphragm motors. Let us ship your burner valve assemblies complete with brackets, levers, etc. ready to mount and operate. Eliminate headaches . . . write for BULLETIN B1020 while you're thinking of it.

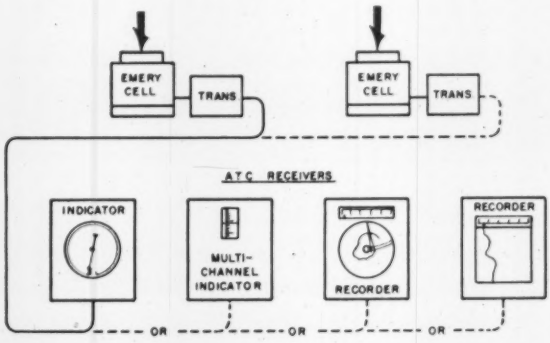
CONOFLOW CORPORATION
2100 ARCH ST.
PHILADELPHIA 3, PA.

CC 112

Cono-Controls

For more information circle **95** on inquiry card.

BRIEFS—CONTINUED



recorder. The load sensitive element is the Emery Hydraulic Cell. The pressure is transmitted by a pipe line to an indicator or recorder which is calibrated to read in terms of pounds or kilograms of load applied on the piston of the cell. *(From new 44-page catalog "Weighing Systems, Hydraulic and Pneumatic, A. H. Emery Co., New Canaan, Conn.)*

For this literature circle **405** on inquiry card.

Mono-accelerator CR Tube

The DuMont mono-accelerator cathode-ray tube is the culmination of years of development . . . all acceleration of the electron beam occurs within the electron gun. Features: no loss of brightness or spot size at low accelerating voltages, low field distortion, lower accelerating voltage, automatic focus, no overscanning glow.

The new "Type 323" oscillograph features mono-accelerator tube, high-gain vertical amplifier with response from

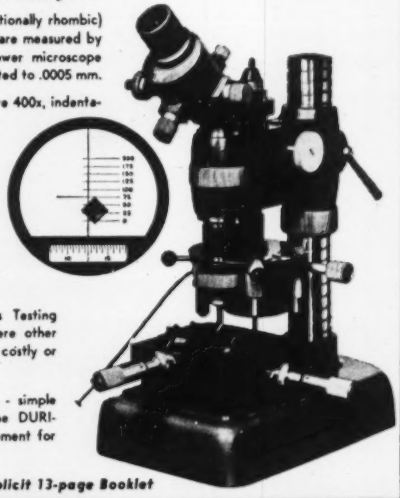
ADVANCE IN HARDNESS TESTING with the NEW DURIMET HARDNESS TESTER

Even the most delicate and highly finished parts or tools may be tested for hardness WITHOUT DAMAGING or DEFORMING THE FINEST FINISH.

The diamond impressions (invisible to the naked eye) are produced with loads of only 15 to 300 grams.

The pyramid (or optionally rhombic) shaped impressions are measured by means of a 400-power microscope with reticule graduated to .0005 mm.

Microscope objective 400x, indentator as well as an extra 100x locating objective are mounted on a common revolving turret for quick indexing on the impression.



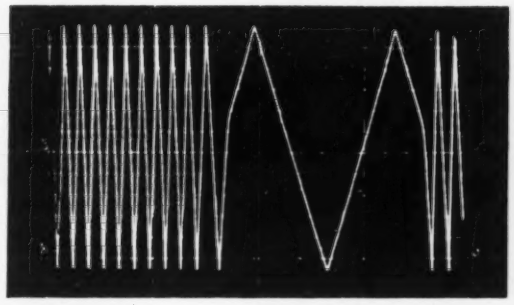
The DURIMET opens up a NEW FIELD of Hardness Testing for every shop where other methods prove too costly or unsuitable.

A reasonable price - simple operation, make the DURIMET essential equipment for any shop.

Write for our explicit 13-page Booklet

Geo. SCHERR OPTICAL TOOLS, Inc.
200-MG LAFAYETTE STREET • NEW YORK 12, N. Y.

For more information circle **96** on inquiry card.



● Waveform shows a portion of low-frequency triangular wave expanded in the notch. The effective delay on this range is 2,200,000 usec. Note lack of jitter with this long delay.

DC to 20 Mc., calibrated sweeps, amplitude calibration, printed circuitry, and "Notch" sweep wherein a 2-inch segment of the sweep is increased in speed by factor of ten so that any portion of sweep can be expanded while remainder is seen. (*From new* 12-*page Bulletin* 323, *Allen B. DuMont Labs, 760 Bloomfield Ave., Clifton, N. J.*)

For this literature circle **406** on inquiry card.

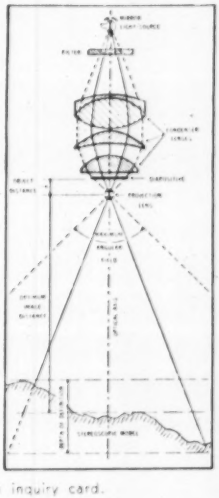
Tilting U-tube Flowmeter

Differential pressure is measured by means of a pivoted manometer which is balanced by a heavy calibrating weight. The use of torsion tubes and anti-friction bearing mounting of the tilting manometer makes the unit virtually frictionless. The high torque provides power to operate the recording pen, indicator and integrator. Actual differential pressure measurement is achieved by a beam balance. There are no springs to calibrate . . . As mercury shifts to the low-pressure cylinder, this side of the balance becomes heavier and the balance swings until the new position of equilibrium is reached . . . To hold tipping of the balance directly proportional to *rate* of flow, the motion is controlled by a precisely contoured cam which presses against a weighted nickel-silver ribbon. (*From new* 4-*page Catalog* 1027, *Penn Industrial Corp., Penn Bldg., Phila.* 4, *Pa.*)

For this literature circle **407** on inquiry card.

Multiplex Mapping

This equipment consists of a group of correlated instruments which transform overlapping aerial photographs into accurate topographic maps. A stereoscopic scale model is formed by projecting a pair of diapositive plates, which are positive reductions of an overlapping pair of aerial negatives, through filters of complementary colors. The image is observed through filter spectacles of the same colors, creating the effect of a three-dimensional model from which the map is compiled. (*From new* 28-*page brochure "Photogrammetric Equipment," Bausch & Lomb Optical Co., Rochester* 2, *N. Y.*)



For this literature circle **408** on inquiry card.

3-dimensional Drawing

Axonometric Projection and Axonometric Drawing, in their three typical modes: Trimetric, Dimetric and Isometric, are generally known for generations. Yet, it seems many

Now... Bristol thermocouples with metal-ceramic protecting tubes

Bristol's new metal-ceramic LT-1 protecting tubes are the most important advance in thermocouple technology in years.

Combining the thermal conductivity and shock resistance of metal with the corrosion and oxidation resistance of ceramic materials, the new protecting tubes will last far longer than ordinary tubes, give you closer control and faster response.

Here are the advantages of the metal-ceramic LT-1's

- Resistance to combustion gases at temperatures up to 3100°F
- Resistance to oxidation in air at temperatures up to 2200°F
- Retention of strength at high temperatures – 1800 to 2500°F
- Greatly superior to most ceramics in resistance to thermal shock
- Resistance to attack by molten metals and furnace slag
- Increased sensitivity – the ⅛ inch wall has a high thermal conductivity

Get the whole story on Bristol's new tubes. Write for Bulletin P1261 today. The Bristol Company, 113 Bristol Road, Waterbury, Conn.

4.19

BRISTOL

Points the Way in Human-Engineered Instrumentation

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **97** on inquiry card.

NEW "Lifetime" Dial Thermometers

You're *always* sure of accurate temperature readings with this new Foxboro "Lifetime" Dial Thermometer. Welded "one-piece" bulb and connecting capillary tubing of 316 Stainless Steel prevent corrosion from liquids, fumes or vapors. Needs no protective tubing. Tightly sealed 5" aluminum alloy case. Available in standard ranges to 1000°F. Easy-to-read scale 12" long. Write for details. **The Foxboro Company, 466 Neponset Ave., Foxboro, Mass., U.S.A.**

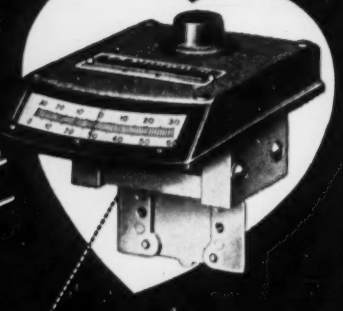
FOXBORO Reg. U.S. Pat. Off. **DIAL THERMOMETERS**

For more information circle **98** on inquiry card.

Make a **GM** **PORTABLE D'ARSONVAL**

GALVANOMETER

the Heart of Your Instrument



FOR MEASURING LIGHT reflectance and color, the Photovolt Corporation of New York uses a Model 600 G-M Galvanometer for its popular Reflection Meter (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

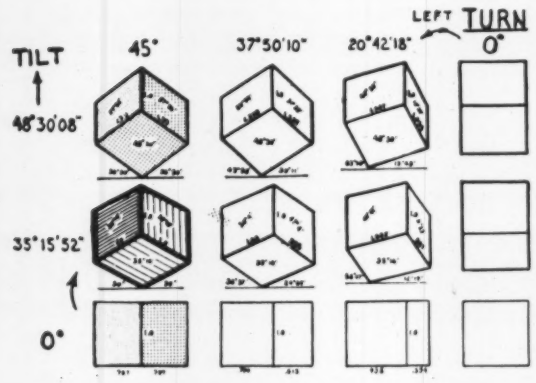
GM LABORATORIES · INC.

In Canada: Cossor (Canada) Ltd., 301 Windsor St., Halifax, N. S.

4316 NORTH KNOX AVE., CHICAGO 41

For more information circle **99** on inquiry card.

BRIEFS—CONTINUED

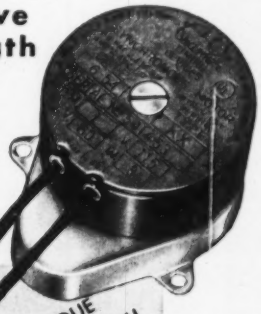


students and even adepts of this application of descriptive geometry are rather following rules of procedure than exercising the art of scalable, one-view or three-dimensional illustration on the basis of full understanding of underlying mathematical laws.

If a cube is turned and tilted through odd angles haphazardly the degree of foreshortening along the three axes, i.e. the scales, and the corner angles representing the 90°, will all differ from each other. In other words, one has to expect to obtain a Trimetric Projection.

If the cube is turned side-ways through 45 degrees, two scales are identical . . . thus, the whole vertical column of cubes at the right hand and likewise at the left hand margin of the illustration contains a family of *dimetric* projections. So we have learned that the case of Dimetric is a special case within the unlimited number of trimetric possibilities.

reserve strength



Cramer KX SYNCHRONOUS MOTOR

POWERFUL HIGH TORQUE
30 IN. OZ. AT 1 R.P.M.
TRULY SYNCHRONOUS
WIDE RANGE OF SPEED
RIGHT OR LEFT ROTATION. HIGH TORQUE
INSTANT START AND STOP. RESERVE STRENGTH
RUNS IN ANY POSITION. COMPACT DESIGN
WIDE VARIETY OF OUTPUT SHAFTS. POWERFUL
ONE OR TWO-WAY FRICTION. ADAPTABLE
RUGGED. PRECISION-CUT GEARS
LUBRICATED FOR LIFE

Write today... KX Motor Bulletin

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., Inc.

BOX 5 CENTERBROOK, CONNECTICUT

9CR54

For more information circle **100** on inquiry card.

Now, the simplification leading to dimetric symmetry can be carried further. Since, in the example examined before, the symmetry has been obtained by fixing the amount of turn to 45 degrees, the proper selection of a certain angle of tilt results in a position in which the scale on the third axis or cube edge becomes equal to the two others, or the two identical angles of projection become equal to the third one, or the two identical corner angles become 120 degrees and therefore identical with the third angle. The one and only angle of tilt which yields this simplest mode of all axonometric projection is, odd as it may seem, 35°15′52″. This case is called *Isometric* because all scales are equal. It is emphasized within the right and left hand marginal column. We have learned that Isometric is one special case of the dimetric family.

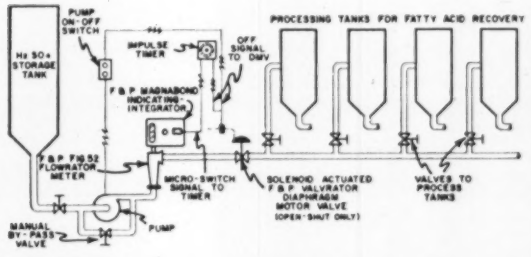
Most suitable for all-around purposes is a dimetric system . . . a suitable dimetric system is based on scale ratios 1 : 1 : .5.

While the dimetric system based on 1 : 1 : .5 scale ratio has its merits a second dimetric system has been introduced by "Instrumaster" lately and may become the standard system of dimetric drawing. (*From new 26-page booklet "3D Drafting," John R. Cassell Co., Inc., 110 W. 42 St., N. Y., N. Y.*)

For this literature circle **409** on inquiry card.

Batch Metering

Prior to the present system, acid flowing from the storage tank to the various soap stock processing tanks was bled into an "acid egg," a large enclosed pressure-tight chamber . . . and air pressure forced the acid to the processing


PROCESSING TANKS FOR FATTY ACID RECOVERY
PUMP ON-OFF SWITCH
IMPULSE TIMER
OFF SIGNAL TO DMV
Hz SO4 STORAGE TANK
F & P MAGNABOND INDICATING INTEGRATOR
F & P FIG.52 FLOWRATOR METER
MICRO-SWITCH SIGNAL TO TIMER
SOLENOID ACTUATED F & P VALVRATOR DIAPHRAGM MOTOR VALVE (OPEN-SHUT ONLY)
VALVES TO PROCESS TANKS
MANUAL BY-PASS VALVE
PUMP

tanks . . . integrating the acid delivered to the processing tanks consisted merely of counting the number of "eggfuls" delivered.

The present system has the acid fed by gravity to the inlet side of a centrifugal pump. The pump delivers to an F&P Fig. 52 corrosion-resistant armored flow meter. In operation, valves to the selected tanks are opened, and the timer is set for total number of gallons to be delivered. Flow proceeds through the diaphragm motor valve to the tanks. The Magnabond housing encloses an integrator to which an impulse timer is attached. After receiving a set number of impulses this timer automatically de-energizes a solenoid coil to close the diaphragm motor valve. (*From 4-page Vol. 3 No. 2 issue of "Ratonews," Fischer & Porter Co., Hatboro, Pa.*)

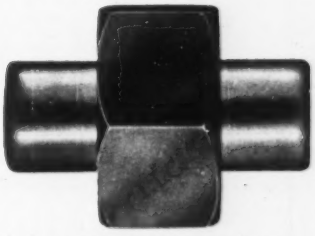
For this literature circle **410** on inquiry card.

Weight Indicators

Handling costs are 22 percent of the average labor payroll and account for as much as 70 percent of the cost of some products. In one large stainless steel fabricating plant, it required 150 men and 4 cranes about 3 days to pick up stocks, move them or roll them to scales, record the weights and replace the coils in their proper storage place. Through the use of crane scales, inventory is now taken in this same plant in about ½ day with only 4 men. A single inventory paid for the cost of the scales leaving their use free for the remainder of the year. (*From 6-page Bulletin W-2, W. C. Dillon & Co., Van Nuys, Calif.*)

For this literature circle **411** on inquiry card.

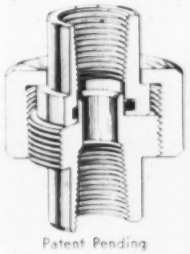
I.I.C. SUR-WAY UNIONS



ABSOLUTELY

NO LEAKS

FINGER-TIGHT



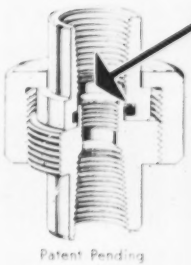
Patent Pending

STANDARD UNION

The I.I.C. Sur-Way Union is designed to give long life and safe, trouble-free service. It's leak-proof even when only finger-tight (vacuum or 5,000 p. s. i.) — the real solution to your instrument, laboratory, refinery or oilfield union problems.

All I.I.C. Sur-Way Unions, including orifice unions shown below, are available in alloy steel, stainless steel and brass, in all sizes up to 2", inclusive. Operating pressures to 5,000 c.w.p.s.i., tested to 15,000 p. s. i. Temperatures to 300° F.

IMMEDIATE DELIVERY FROM STOCK ON SIZES ¼" AND ½" OF ALLOY STEEL (CADMIUM PLATED).



Patent Pending

NEW

ORIFICE UNION
WITH SCREW-IN ORIFICES

I.I.C. Sur-Way Orifice Unions are furnished with stainless steel orifices bored to specified size. This new type orifice is easy to insert or remove.

Write for Bulletin 58-A.

INDUSTRIAL INSTRUMENT CORP.

BOX 1909 ODESSA, TEXAS

For more information circle **101** on inquiry card.

MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price.

LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

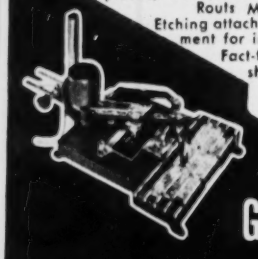
MARSHALLTOWN MANUFACTURING CO.
MARSHALLTOWN 3, IOWA

For more information circle **102** on inquiry card.

Versatility with a GREEN ENGRAVER

ENGRAVES
PANELS
DIALS
PLATES

Mark your own symbols, numbers, lettering, on your small parts, tools, identification and name plates . . easily, simply, quickly . . tracing from a master with the GREEN ENGRAVER. Widely used in electronic and plastic fields, in machine tool shops and wherever permanent marking is needed. The GREEN ENGRAVER engraves equally well on metals, plastic, wood, hard rubber and glass. Routs Models Profiles Engraves Etching attachment and other special equipment for industrial uses are available. Fact-filled folder on request showing how economies in costs, labor and time are achieved with the GREEN ENGRAVER.



GREEN
INSTRUMENT COMPANY
383 PUTNAM AVE., CAMBRIDGE, MASS.

For more information circle **103** on inquiry card.

BRIEFS—CONTINUED

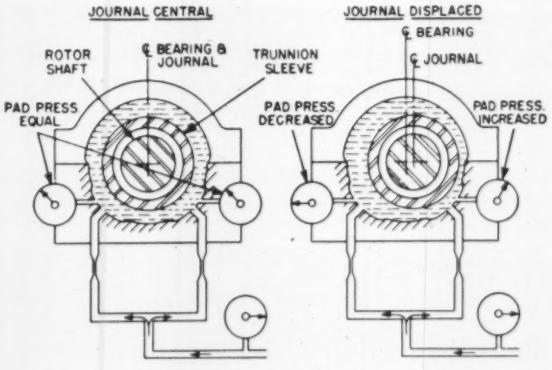
Dynamometers with Oil-floated Trunnion Bearings

The G-E d-c dynamometer measures input or output torque of rotating equipments—in either direction—with a high degree of accuracy.

In principle, it is a shunt-wound motor or generator. Torque delivered by (or to) the apparatus under test is transmitted to the dynamometer stator from its rotor by means of a magnetic linkage. Torque measuring equipment, connected to the cradled stator, reports the stator reaction in terms of net torque at the shaft of the apparatus under test.

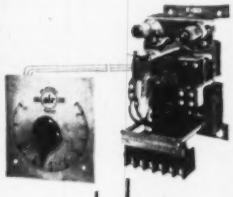
The amplidyne, a two-stage rotating amplifier, acts as an exciter for the dynamometer and the generator.

The G-E inductor dynamometer, unlike the d-c dyna-



high repeat accuracy

unaffected by tube age, voltage or temperature variations



INTEGRAL OR AT ANY DISTANCE

For intervals from .02 to 30 sec., the "Atcotronic" Timer provides precise control of machine and process operations.

Compact design requires little panel space. The absence of moving parts assures dependable, trouble-free operation.

Two types, nine enclosure styles, four load actions. Most models in stock. For complete data, write for Bulletin N-90. Automatic Temperature Control Co., Inc., 5224 Pulaski Ave. Phila. 44, Pa.

atc®

ELECTRONIC TIMERS

For more information circle **104** on inquiry card.

mometer, is used only to absorb power. It consists principally of a smooth cylindrical rotor, a stator having projecting magnetic teeth, and a toroidal d-c field coil. Power input to the dynamometer shaft is changed into eddy-current losses in the rotor, and the resultant heat is dissipated by cooling water. Power absorption is controlled simply by regulating a small d-c current in the dynamometer field.

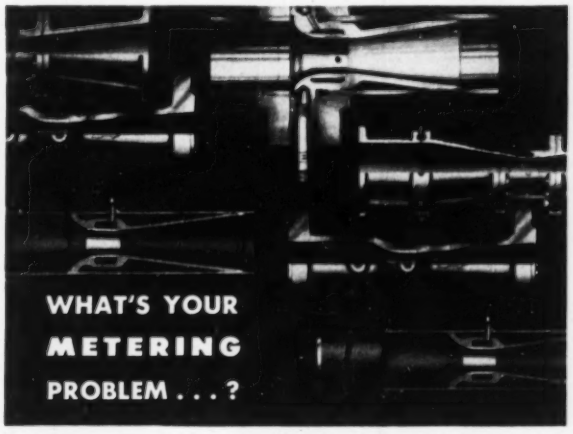
General Electric's revolutionary new oil-floated trunnion bearing (see illustration) for G-E dynamometer is one of the most important recent improvements. With it, bearing friction can be reduced to a co-efficient of less than one-thousandth of the least co-efficient possible with conventional bearings. (*From new 12-page brochure GEA-5923, General Electric, Schenectady, N. Y.*)

For this literature circle **412** on inquiry card.

Potentiometer Noise

The author has attempted to arrive at a system of units which will be valid and unambiguous in any potentiometer application. This system is based on a measurable "potenti-

Noise Type	Origin	Expression (Noise Figure)
Loading Noise	Load current flowing through fluctuating contact resistance.	Ohms (peak-to-peak variation in contact resistance).
Shorting Noise	Winding current flowing through fluctuating contact resistance.	Equivalent ohms peak-to-peak (calculated from an observed winding current and noise voltage).
Resolution Noise (due to winding current)	Stepped nature of wire-wound resistance element.	Per cent. (reciprocal of number of turns of resistance wire).
Resolution Noise (due to load current)	Stepped nature of wire-wound resistance element.	Ohms (resistance per turn of resistance wire).
Generated Noise	Tribo effect.	Millivolts or microvolts.
High Velocity Noise	Brush leaving winding above critical velocity.	In terms of pulse width and critical velocity.



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BASIC SWITCH
MECHANICAL LIFE SPAN OVER 10,000,000 OPERATIONS

Cut-Away View of Type S2

Here's the Precision Switch that Gives You Extra Features at No Extra Cost

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  Carries life rating of 10,000,000 mechanical operations with precise repeatability of entire life of switch.
- ***HIGH CAPACITY***
  UL rated at 10 amps, 125/250 v. ac or 30 v. dc. Wiping action of contacts reduces arcing for long electrical life.
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  Durable plastic case measures only 1¼" long, ½" wide and ½" high, permitting more compact designs and mounting arrangements.

Send for details in Specification Sheet STG-6

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Alnor, pioneer in the field of electronic temperature instruments, brings you automatic, precise temperature control for heat-treating furnaces, bake ovens—in fact, for any heating device whether electrically heated or fuel fired. It's the Alnor Temperature Controller—simple in design and operation, its accuracy proved on thousands of installations in many industries.

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HI-DUTY TUBE CUTTER
Free wheeling ball bearing action. Roller type with flare cut-off groove. Retractable reamer. **No. 274-F** for 1/8" to 1" tubing. Other models. Also saw-ing vises.

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All types, for making 45°, 37° and double flares . . . on copper, aluminum, steel and stainless steel tubing. **No. 500-F** Flaring Tool, illustrated, makes 45° flares and then burnishes them.

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Lever-type, gear-type and spring-type benders for bending all kinds of tubing. Illustrated is **No. 364-F** individual lever-type bender. Also models that take a wide range of sizes.

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BRIEFS—CONTINUED

ometer noise figure" (for each type of noise) which can be used to compare directly the "noise qualities" of several potentiometers and which will enable the user to predict the magnitude of each type of noise voltage under any operating conditions. The use of a noise figure, the value of which depends on the operating condition, has been avoided.

The several types of potentiometer noise discussed here may be summarized with regard to origin and possible modes of expression:

(From new 12-page booklet "Electrical Noise in Wire-wound Potentiometers," Helipot Corp., S. Pasadena, Calif.)

For this literature circle **413** on inquiry card.

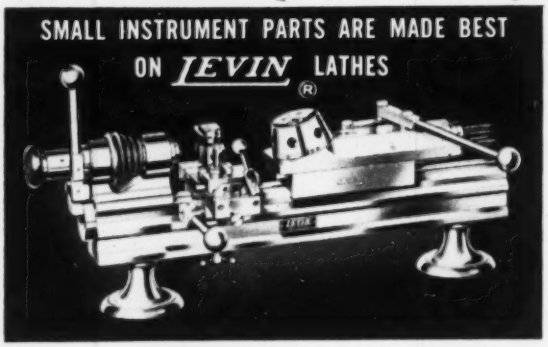
Transfer Volt-ammeter

Hermach-Engelhard Transfer Volt-Ammeter combines wide frequency range, sensitivity and multiple current and voltage ranges possible with thermocouple instruments;

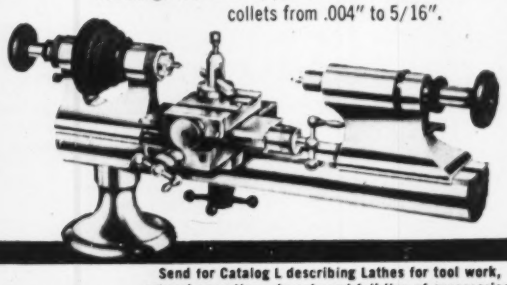
it completely eliminates disadvantages which previously limited the accuracy and usefulness of thermocouple instruments. . . . Results are read on the external D.C. potentiometer in a conventional way to give measured amps or volts to 0.05 percent, without correction, at all audio frequencies up to 20,000 cps. *(From 4-page brochure, Charles Engelhard, Inc., 850 Passaic Ave., E. Newark, N. J.)*

For this literature circle **414** on inquiry card.

SMALL INSTRUMENT PARTS ARE MADE BEST ON LEVIN® LATHES



Twenty-three models for all types of work. 4" swing, Bed Length 12" or 18"; over 100 stock sizes of collets from .004" to 5/16".



Send for Catalog L describing Lathes for tool work, second operations; turrets and full line of accessories.

LOUIS LEVIN & SON, INC., 3610 S. Broadway, Los Angeles 7, Calif.

For more information circle **110** on inquiry card.

30-kc. Decade Scaler

The Norelco Decade Stage utilizes the new E1T counter tube designed principally for the counting and indicating of electrical pulses. In a single glass envelope, the E1T

possesses the structure which permits it to count to *ten*—and to indicate the count by a bright fluorescent number. A second tube, type 5964, performs the pulse-shaping function between stages. (*From new 4-page bulletin, North American Philips Co., Mt. Vernon, N. Y.*)

For this literature circle **415** on inquiry card.

Lab Layout Kit

Included with this catalog is a complete layout kit which consists of a base scale sheet cross ruled in ½" squares, each square representing one square foot. Also included is a complete set of accurately scaled 3-dimensional cardboard models. These models are made in the form of small boxes . . . all you need to do is fold them up, tuck the ends in and you have a complete set of 26 sectional pieces. . . . As soon as your models are in final placement, glue them into position . . . you now have a perfect miniature lab set-up that can be discussed with your co-workers or with management for O.K. (*From new 28-page Catalog F-153, Labline, Inc., 217 N. Desplaines St., Chicago, Ill.*)

For this literature circle **416** on inquiry card.

1
2
3
Contact Blade Spacer
Coil Form
Coil Form Insulator Bushing
Coil Form Terminal Board
Shoulder Washer
Germanium Crystal Holder
Stand-Off Insulator
BEFORE YOU SPEND TIME AND EFFORT TO DESIGN YOUR OWN MOLDED PLASTIC PARTS — THINK OF SAVING THAT COST, PLUS TOOL COSTS, WITH THESE GRAYHILL STOCK PARTS. ASK FOR COMPLETE INFORMATION AND CATALOG.
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Combine high and low temperatures within the same cabinet with all controls self contained. Unit measures 50"x28"x20" with a testing chamber 12"x12"x12". Temperature range is from -80° F. to 185° F. Heat application is accomplished with reverse cycle refrigeration, which eliminates the hazards associated with open heating elements. A blower is provided for even distribution of temperatures and greater testing accuracy. Latch-type or hinge-type door optional. Accelerated pull-down to -80° in 30 minutes or less.

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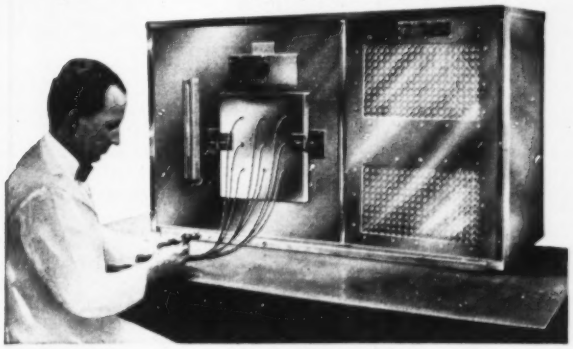

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On any air or gas line 92% of the dirt, oil, scale and water that enter the Aridifier is trapped and removed from circulation. The Aridifier's patented centrifugal-baffle action scrubs air and gas clean and dry . . . protects equipment, prevents freezing, fouling, corrosion and caking, produces best results with spray gun and air tool operations, etc. Easy to install. Self cleaning. Maintains itself. 10 models available. Capacity 7 CFM to 17,000 CFM.

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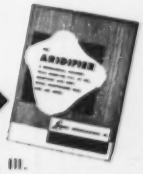

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For more information circle **113** on inquiry card.

MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 983.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

AUTOMATION

Magnetic-tape Machine Control. New 6-page Bulletin GEA-6092, describes maker's record-playback control, a system of recording motion on magnetic tape and playing it back for automatic programming of production machines and processes.—General Electric, Schenectady 5, N. Y.

Circle **417** on inquiry card.

Control Instruments. New 24-page issue of "Taylor Technology" (Vol. 6 No. 3) contains articles on cascade control systems and on use of control in production of drugs and other industries.—Taylor Instrument Cos., Rochester 1, N. Y.

Circle **418** on inquiry card.

Industrial Instruments. New 24-page Catalog 5001 describes and illustrates maker's line of indication, recording and control instruments. Includes potentiometers, thermometers, pressure gages, flow and liquid level meters, etc.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **419** on inquiry card.

Power Distribution Equipment. New 4-page Bulletin 1052 pictures electrical distribution and control equipment "covering every link between utility source and industrial application."—Continental Electric Equipment Co., Box 1055, Cincinnati 1, Ohio.

Circle **420** on inquiry card.

Pneumatic Control. New 6-page Bulletin M-542 describes maker's autopneumatic control with linear output speeds for automatically controlling temperature, liquid level, pressure, flow, etc.—Reeves Pulley Co., Columbus, Ind.

Circle **421** on inquiry card.

Control Equipment. New 34-page Bulletin 004 presents maker's line of equipment for measurement and control of liquids and gases. Includes controllers, gages, manometers, recorders, meters, valves, Venturi tubes, etc.—Simplex Valve & Meter Co., 68th & Upland St., Phila., Pa.

Circle **422** on inquiry card.

Instrumentation Index. New 8-page Alphabetical Index 200-C covers all issues of "Instrumentation Magazine" published from 1943 through 1953.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **423** on inquiry card.

Industrial Instrumentation. New 48-page issue of "Instrumentation" (Vol. 7, No. 3) contains articles on instrumentation in canning industry, petroleum research, etc.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **424** on inquiry card.

SERVOS, MOTORS

Control, Gearhead Motors. New 4-page illustrated brochure presents description and specifications of maker's new line of miniaturized 400-cycle control and hysteresis synchronous motors and gearhead motors.—Servomechanisms, Inc., 625 Main St., Westbury, L. I., N. Y.

Circle **425** on inquiry card.

Synchros. New 2-page Bulletin CD-10 and SG-17-1-A describe and illustrate maker's control synchro differential and gyro synchro transmitter.—Clifton Precision Products Co., Inc., Clifton Heights, Pa.

Circle **426** on inquiry card.

Electric Motors. New 4-page issue of the "Motorgram" (Vol. 34, No. 3) contains articles on applications of maker's motors and characteristics of the governor motor.—Bodine Electric Co., 2250 W. Ohio St., Chicago 12, Ill.

Circle **427** on inquiry card.

Motors, Servos. New 2-page bulletin illustrates maker's line of miniature servomechanism components. Includes induction resolvers, hysteresis motors, servo motors, etc.—American Electronic Mfg., Inc., 9503 W. Jefferson Blvd., Culver City, Calif.

Circle **428** on inquiry card.

Motors, Timers, Electronic Components. New 16-page illustrated catalog presents distributor's large line of electronic equipment and radio parts.—Herbach & Rademan, Inc., 1204 Arch St., Phila., Pa.

Circle **429** on inquiry card.

Variable-speed Control, Drive. New 4-page Bulletin 4534-25 and 2-page insert announces maker's new electronic variable-speed control for fractional-horsepower-series motors, and electronic variable-speed drive.—Arrow-Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford, Conn.

Circle **430** on inquiry card.

VALVES

Direct-lift Valve. New 2-page Technical Bulletin 100 presents specifications for maker's stainless-steel barstock direct-lift valve.—Atkomatic Valve Co., 545 West Abbot St., Indianapolis, Ind.

Circle **431** on inquiry card.

Valves. New 4-page illustrated Bulletin 608, 158 describes maker's hydramotor and airmotor valves, and instruments for measurement and control. New 4-page Bulletin 608, 170 presents features, specifications, and dimensions of maker's manual reset thermopilot valves for heating and gas appliances.—General Controls, Glendale, Calif.

Circle **432** on inquiry card.

Valves. New 18-page issue of "The Flow Line" (Vol. 13, No. 2) features article on applications of maker's valves in oil industry.—Rockwell Mfg. Co., Pittsburgh, Pa.

Circle **433** on inquiry card.

Valve, Pump Packings. New 12-page Bulletin TP-1053 describes and illustrates maker's "Teflon" valve and pump packings.—United States Gasket Co., Camden, N. J.

Circle **434** on inquiry card.

Servo Valves. New 12-page bulletin describes and illustrates maker's "Model 500", "Model 900" and "Model 1400" proportional-type electrically-actuated hydraulic four-way valves.—Moog Valve Co., Inc., Proner Airport, East Aurora, N. Y.

Circle **435** on inquiry card.

Pressure-reducing Valves. New 8-page Reprint 100-K29 on "Dual Ranging Shuntflo Meters by Means of Squires Pressure Reducing Valves" describes system used to obtain accuracies of 2 percent over a wide range and variable steam load.—Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle **436** on inquiry card.

Valves. New 2-page illustrated Brochure 11-A-24 describes maker's "CV Series" electric-solenoid-operated valves for air, water, and low pressure hydraulic service.—Modernair Corp., 400 Preda St., San Leandro, Calif.

Circle **437** on inquiry card.

Electric Actuators. New 64-page Catalog 3-1-1 presents description, applications, and specifications of maker's electric, linear, and rotary actuators.—AiResearch Mfg. Co., 9851-9951 Sepulveda Blvd., Los Angeles, Calif.

Circle **438** on inquiry card.

Flow-control Valves. New 4-page illustrated Bulletin 53-35 describes maker's "Microfeed" flow-control valves for machine-tool and oil-hydraulic systems.—Vickers Inc., 1400 Oakman Blvd., Detroit, Mich.

Circle **439** on inquiry card.

TEMPERATURE

Thermistors. New 52-page Manual TH-13 presents operating characteristics, applications and description of maker's line of thermistors.—Carboloy Department, General Electric Co., Detroit, Mich.

Circle **440** on inquiry card.

Fire Detection System. New 2-page issue of "Instrument News" contains article describing maker's fire-detector

New!

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Multiple-Unit Reset Counter

DESIGNED TO COUNT ANYTHING COUNTABLE

this new Vary-Tally can be supplied in any combination up to 6 banks high, 12 units wide, with the counting units arranged compactly on stands in tiers. Now check these special features of Veeder-Root design and construction:

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- Individual Tag Above Each Counter-Window — Not Strip Tabs
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cable for aircraft.—Thomas A. Edison, Inc., West Orange, N. J.

Circle **441** on inquiry card.

Thermocouples, Glands. New 14-page Catalog 1530 describes and illustrates maker's full line of thermocouples and packing glands.—Conax Corp., 4515 Main St., Buffalo, N. Y.

Circle **442** on inquiry card.

Thermocouple Converter. New 2-page Bulletin A-712 presents description and principles of maker's "Type T2C" thermocouple converter, an amplifier converter unit which enables "Autronic" System to be used with thermocouples or other low-voltage d-c. input equipment.—Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Circle **443** on inquiry card.

Industrial Thermometers. New 14-page Catalog 101 describes and illustrates maker's line of industrial thermometers. Includes new "Multi-Angle" industrial, and temperature equivalent table.—United States Gauge, Div. of American Machine and Metals Inc., Sellersville, Pa.

Circle **444** on inquiry card.

Heat-flow Transducer. New 2-page Form 200 illustrates and describes maker's "Model 200" thermopile heat-flow transducers.—Beckman & Whitley, Inc., 1096 E. San Carlos Ave., San Carlos, Calif.

Circle **445** on inquiry card.

Temperature Control. New 2-page Bulletin 102 presents specifications and description of maker's "Models V-1C" and "V-1X" temperature control with high-temperature safety alarms and cut-outs up to 1800 deg. F.—Burling Instrument Co., Inc., 16 River Rd., Chatham, N. J.

Circle **446** on inquiry card.

Radiamatic Pyrometers. New 24-page Catalog 9301 presents specifications and applications of four types of radiamatic radiation detectors for measuring temperatures from 125 to 7000 deg. F.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **447** on inquiry card.

Flame-failure Safeguard. New 12-page illustrated Bulletin CP21 describes applications of maker's "Fir-eye" flame-failure safeguard.—Combustion Control Corp., 718 Beacon St., Boston, Mass.

Circle **448** on inquiry card.

Temperature Controller. New 2-page Bulletin 6430 describes maker's dual temperature controller, which incorporates two complete systems for measuring, indicating and controlling two temperatures.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **449** on inquiry card.

Bimetal Thermostats. New 2-page Bulletin F-2009 describes maker's line of "Type M" bimetal disc thermostats for electronic devices and apparatus.—Stevens Mfg. Co., 69 S. Walnut St., Mansfield, Ohio.

Circle **450** on inquiry card.

Pyrometer Accessories. New 32-page Catalog 4-54 presents maker's line of pyrometer accessories. Includes protection tubes, replacement elements, assembled thermocouples, thermocouple wire, etc.—West Instrument Corp., 525 North Noble St., Chicago 22, Ill.

Circle **451** on inquiry card.

Thermistor Bolometer. New 2-page Bulletin ODC-413 describes principle and applications of maker's "Type BC-1" infrared thermistor bolometer.—Olympic Development Co., 30 Commerce Rd., Stamford, Conn.

Circle **452** on inquiry card.

Temperature Controller. New 4-page Bulletin 654 describes operation and features of maker's controller for use in heat treating, injection molding, wire drawing, ceramic kilns, and laboratory furnaces.—Winslow Co., 9 Liberty St., Newark 5, N. J.

Circle **453** on inquiry card.

Electric Heating Units. New 30-page booklet presents descriptions and applications of maker's full line of electric heating equipment.—Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh, Pa.

Circle **454** on inquiry card.

Woven-wire Heating Elements. New 4-page bulletin illustrates and describes maker's line of electrical elements for use with instruments and other equipment to insure operation at low temperatures.—Haddam Mfg. Co., Route 9, Haddam, Conn.

Circle **455** on inquiry card.

Woven Electric Heaters. New 4-page brochure presents descriptions, illustrations and applications of maker's woven electric heaters.—Pre-Fab Heater Co., Guilford, Conn.

Circle **456** on inquiry card.

PRESSURE

Pressure Transducers. New 12-page Bulletin PT-1 describes maker's pressure transducers for the measurement of gage, differential, and absolute pressures.—Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles, Calif.

Circle **457** on inquiry card.

Pressure Transmitter. New 4-page Bulletin 45000-1 describes and illustrates maker's dual pressure transmitter.—G. M. Giannini & Co., Inc., Pasadena, Calif.

Circle **458** on inquiry card.

Water Pressure Control. New 8-page reprint "Control of Water Pressure in Suburban Distribution Lines" describes three methods by which water pressures can be maintained with boosted pressure.—Automatic Control Co., 995 University Ave., St. Paul 4, Minn.

Circle **459** on inquiry card.

Pressure Transducer. New 4-page Bulletin 625 describes and illustrates maker's "Model EP" engine pressure transducer using wire strain gage bonded to strain tube that is connected to catenary diaphragm.—Control Engineering Corp., Norwood, Mass.

Circle **460** on inquiry card.

Ionization Gage. New 2-page bulletin presents maker's "Model 505" high-vacuum ionization gage.—Philadelphia Scientific Glass Co., 4 Eckard Ave., Abington, Pa.

Circle **461** on inquiry card.

Mechanical Manometers. New 2-page bulletin presents description and diagrams of maker's "Series 311" diff.-press. gages with ranges from 0.2-3 to 2-30 in. water.—Colvin Laboratories, Inc., 364 Glenwood Ave., E. Orange, N. J.

Circle **462** on inquiry card.

Kinetic Leak Detector. New 2-page Bulletin 1500 describes and illustrates maker's portable kinetic leak detector for field and production use.—Kinetic Engineering Co., M-217 Delaware Trust Bldg., Wilmington, Del.

Circle **463** on inquiry card.

Bellows Assemblies. New 2-page Data Sheet 850-1 presents description, operation and applications of maker's differential-pressure bellows assemblies.—Clifford Mfg. Co., Waltham, Mass.

Circle **464** on inquiry card.

Pressure Pickups. New 4-page brochure announces maker's new line of pressure-measuring devices for aerodynamics, hydrodynamics, engine research, pressure control, and ballistics.—Dynamic Instrument Co., Inc., Cambridge, Mass.

Circle **465** on inquiry card.

FLOW

Flowmeters. New 56-page Catalog 2320 illustrates and describes maker's line of flowmeters—indicating, recording, integrating and controlling; graduated and square-root types; area meters and differential converters.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **466** on inquiry card.

Flow Regulators. New 4-page Catalog 10-F-70 presents descriptions, photographs and diagrams of maker's self-operated flow regulators.—Fischer & Porter Co., Hatboro, Pa.

Circle **467** on inquiry card.

Flow Pickup. New 4-page Bulletin 101 presents description, and applications of maker's "Series FL" flow pickups using turbine wheel and electric-pulse output.—Waugh Engineering Co., 15306 Dickens St., Sherman Oaks, Calif.

Circle **468** on inquiry card.

Pumps. New 8-page illustrated Bulletin 491 illustrates and describes maker's line of chemical pressure pumps.—Orchem Pump Div., Orlich Bros. Machine Works, 4434-36 Salmon St., Phila., Pa.

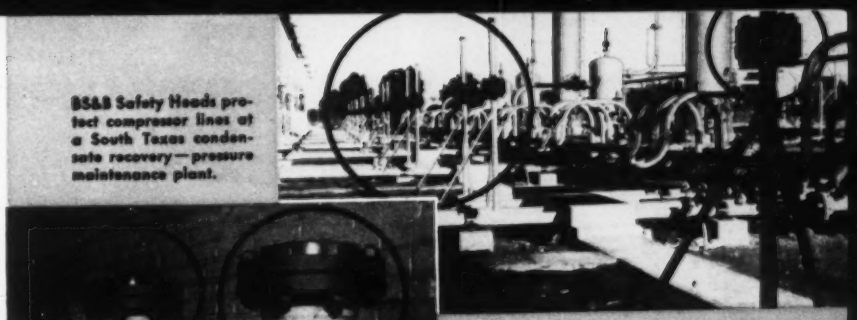
Circle **469** on inquiry card.

LEVEL

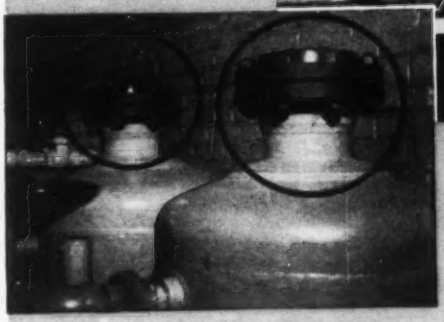
Gages, Valves. New 4-page Data Unit 237 presents maker's heated and cooled gages and valves for getting accurate level readings of liquids that boil or surge or that are heavy and do not flow at normal temperatures.—Jerguson Gage & Valve Co., 80 Fellsway, Somerville, Mass.

Circle **470** on inquiry card.

Circle **116** on inquiry card. ⟶

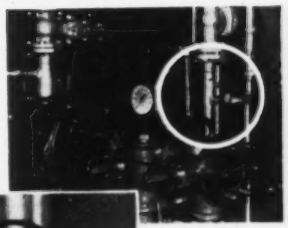


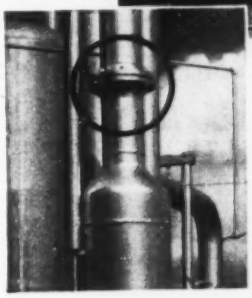
BS&B Safety Heads protect compressor lines at a South Texas condensate recovery—pressure maintenance plant.



Equipment and personnel within a plant are protected from the hazards of overpressure in these vessels by BS&B Safety Heads.

BS&B Safety Heads Have Hundreds of Applications!



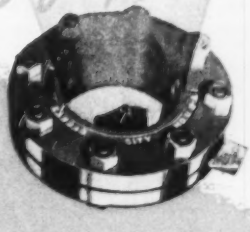


Here a BS&B Union Type Safety Head, with Monel rupture disc, is installed on a two-stage hydrogen compressor.

This BS&B Safety Head is mounted on the flare from a Pop Valve on an incoming gas line.

The variety of possible uses for BS&B Safety Heads is limited only by the number of different ways in which compressed air, gas or liquids—either bland or corrosive—are handled, processed or stored by our many manufacturing and processing industries! Wherever protection of a closed pressure system is required, there is a correct size and type of BS&B Safety Head to do the job! For detailed information, ask your BS&B Representative . . . or write to us direct.

BS&B Safety Heads



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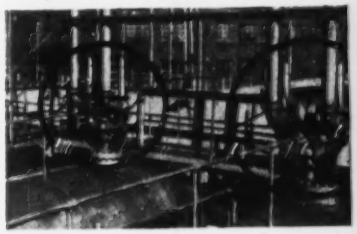

BS&B Combination Safety Head—Relief Valves protect 15,000 gallon butadiene storage tanks at an Akron, Ohio, rubber plant.

BLACK SIVALLS & BRYSON, INC.

Safety Head Division, Dept 2-V6
7500 East 12th St., Kansas City 26, Mo.

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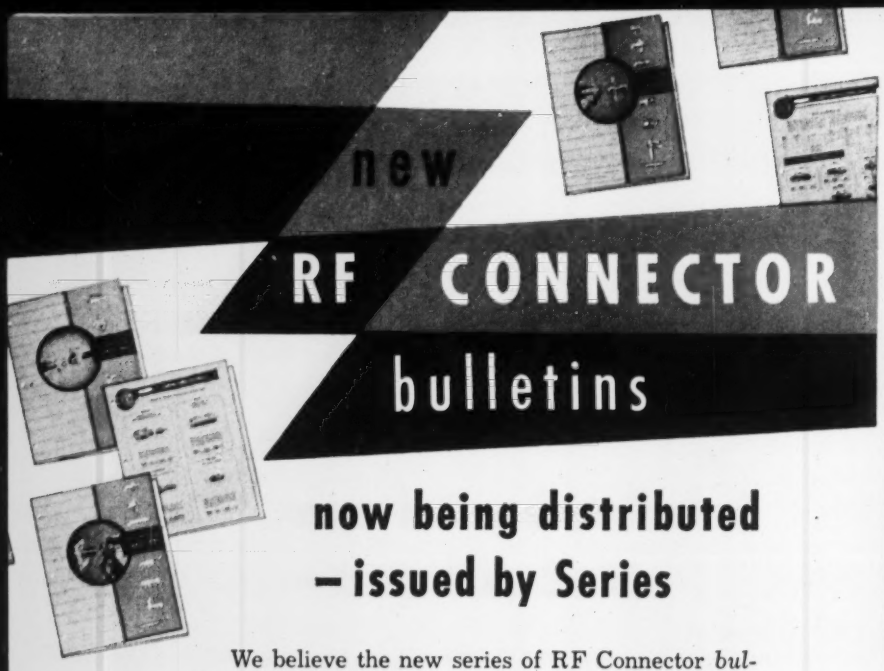

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- ☐ Series UHF
- ☐ Series LC
- ☐ Series C
- ☐ Series Push-On
- ☐ Coaxial Cable Fittings
- ☐ Coaxial Cable Adapters

NEW LITERATURE

Level Gages. New 42-page Handbook 426 presents operating principles, installation and overhaul techniques for maker's diesel locomotive tank-contents gages.—Liquidometer Corp., 41-03 36th St., L. I. C., N. Y.

Circle **471** on inquiry card.

Level Control. New 36-page illustrated catalog presents maker's full line of floatless liquid-level and industrial controls. Includes induction relays, multiple pump controls, electrode holders, ice-free control, etc.—B/W Controller Corp., 2200 E. Maple Rd., Birmingham, Mich.

Circle **472** on inquiry card.

Liquid-level Control. New 4-page issue of "Ratonews" (Vol. 3 No. 3) presents description and applications of maker's automatic liquid-level control.—Fischer & Porter Co., Hatboro, Pa.

Circle **473** on inquiry card.

Level Control. New 24-page Catalog SC-5 describes and illustrates maker's line of boiler water level controls and safety devices. Includes boiler water feeders, pump controllers, small float valves, flow switches, etc.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago, Ill.

Circle **474** on inquiry card.

COMPUTING

Analog Computer. New 4-page illustrated brochure presents description and specifications of maker's new "Type 16-31R" self-contained analog computer.—Electronic Associates Inc., Long Branch, N. J.

Circle **475** on inquiry card.

Resolver. New 2-page illustrated bulletin presents construction, function and technical data for maker's size 15 "Telesyn" resolver, a miniature rotatable transformer.—Ford Instrument Co., 31-10 Thomson Ave., L.I.C., N. Y.

Circle **476** on inquiry card.

Computer Elements. Three new catalog sheets illustrate and describe maker's hollow-shaft differential, ball & disc integrator, and sine-cosine mechanism.—Librascope, Inc., 1607 Flower St., Glendale, Calif.

Circle **477** on inquiry card.

Magnetic-shift Register Assemblies. New 2-page Bulletin 550 describes maker's magnetic-shift register assemblies for digital computers.—Sprague Electric Co., North Adams, Mass.

Circle **478** on inquiry card.

Magnetic Library Systems. New 4-page illustrated brochure describes maker's magnetic-drum-storage system for data.—Logistics Research, Inc., 141 S. Pacific Ave., Redono Beach, Calif.

Circle **479** on inquiry card.

Analog Computer. New 24-page illustrated catalog presents components, specifications and applications of maker's line of "MC-400" analog computers. New 6-page brochure presents "MC-500" analog computers.—Mid-

← Circle **117** on inquiry card.

Century Instrumatic Corp., 611 Broadway, New York, N. Y.

Circle **480** on inquiry card.

Analog Computers. New 8-page reprint presents technique for a simple visualization of scale-factor problem in analog computers.—George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass.

Circle **481** on inquiry card.

Solid Ultrasonic Delay Lines. New 12-page Technical Bulletin 54 presents theory, performance, circuitry and specifications of maker's solid ultrasonic delay lines.—Anderson Laboratories Inc., 39 Talcott Rd., West Hartford, Conn.

Circle **482** on inquiry card.

Digital Computer. New 4-page brochure pictures and describes "Circle" general-purpose digital computer.—Hogan Laboratories, Inc., 155 Perry St., New York, N. Y.

Circle **483** on inquiry card.

RECORDING

Oscillography, Spectrometry. New 16-page issue of "CEC Recordings" (Vol. 8, No. 1) presents articles on recording oscillograph, mass spectrometer, gyroscope development, etc.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **484** on inquiry card.

X-Y Recorder. New 4-page bulletin illustrates and describes rectangular-coordinate recording system for antenna patterns, research, etc., featuring two servo amplifiers (one with logarithmic response).—Airborne Instruments Laboratory, Inc., Mineola, L. I., N. Y.

Circle **485** on inquiry card.

Function Plotter. New 2-page Data Sheet 10.0-17 describes maker's new recorder for automatic plotting, on a single chart, of a curve that continuously evaluates two variables in terms of a third.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **486** on inquiry card.

Graphic Recorder. New 12-page booklet describes "On-the-Spot Fact Finder" 3-channel recorder with one channel-timing; also 1-channel and 50-channel models.—Alden Electronic & Impulse Recording Equip. Co., Westboro, Mass.

Circle **487** on inquiry card.

Transistor Curve Tracer. New 4-page bulletin presents description, applications and specifications of maker's automatic universal transistor curve tracer and accessories.—Magnetic Amplifiers, Inc., 632 Tinton Ave., New York, N. Y.

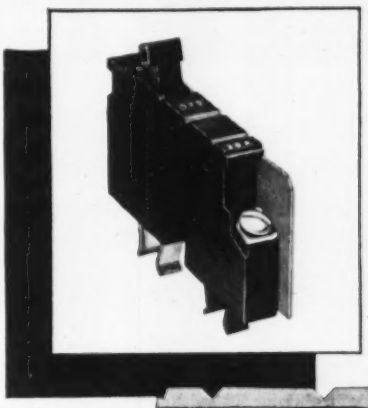
Circle **488** on inquiry card.

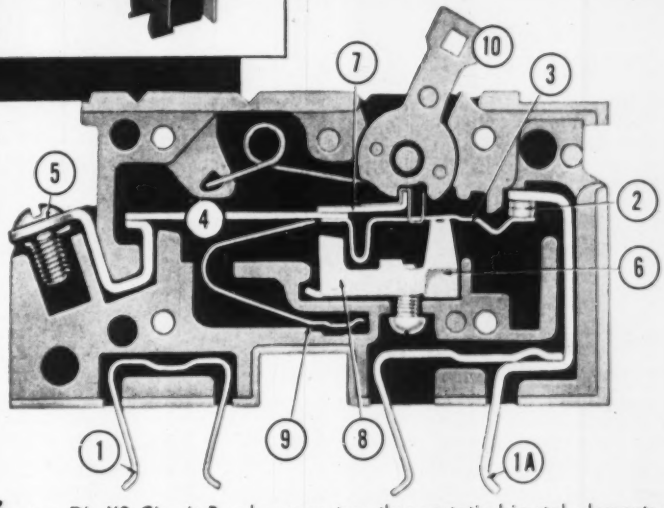
Oscillographic Recording. New 2-page bulletin describes and illustrates maker's "150 Series" industrial oscillographic recorder.—Sanborn Co., 195 Massachusetts Ave., Cambridge 39, Mass.

Circle **489** on inquiry card.

Multichannel Oscillograph. New 8-page brochure describes maker's mag-

HOW CHACE THERMOSTATIC BIMETAL PROTECTS IN THE SQUARE D XO CIRCUIT BREAKER





Square D's XO Circuit Breaker uses two thermostatic bimetal elements to attain simplicity and safety. This load center device provides easy installation and adaptability to changing condition.

The typical circuit breaker once had 27 operating parts; a recent one had five. The Square D XO unit has but three. Its thermal-magnetic-spring restricted system gives positive, quick action under varying load conditions.

The breaker is mounted on bus bars in enclosures by spring clips (1) and (1A) and can be quickly installed and removed. Current flows from the bus bar to spring clip (1A), through the contact points (2) to the blade (3), then through the thermostatic bimetal element (4) to the terminal (5).

As the thermostatic bimetal element (4) becomes heated by overload, it deflects downward but movement is restricted temporarily by the jaws of spring latch (6), through which it must pass. A heavy overload increases magnetism in armature (7) which is attracted to yoke (8) giving added force to breaking action. The Chace Thermostatic Bimetal element (9) compensates for ambient temperature in the installation. Spring loaded handle (10) moves to left to signal opening of circuit and locks breaker contacts in open position.

Leading manufacturers of products responsive to changes in temperature take advantage of the consulting service we offer. Before you proceed with that new design write for our new 36 page booklet, "Successful Applications of Chace Thermostatic Bimetal." Then, remember, Chace supplies thermostatic bimetal in 29 types, in strip, random lengths or completely fabricated elements of your design.

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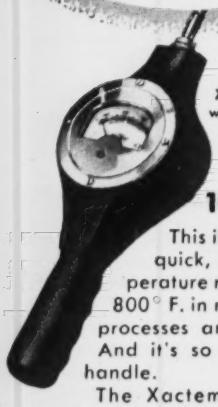

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MANUFACTURER'S NEW LITERATURE

netic multiple-image recording-reproducing system with response from 5 to 500 cps.—Techno Instrument Co., 6666 Lexington Ave., Los Angeles 38, Calif.

Circle **490** on inquiry card.

Recorder. New 6-page brochure describes and illustrates maker's "MC-300" six-channel recorder.—Mid-Century Instrumatic Corp., 611 Broadway, New York, N. Y.

Circle **491** on inquiry card.

Photorecording. New 4-page leaflet describes photographic characteristics and winding specifications available in maker's photorecording papers and films for use in oscillographs and other recording instruments.—Eastman Kodak Co., Industrial Photographic Div., Rochester, N. Y.

Circle **492** on inquiry card.

Tape Monitor System. New 8-page illustrated brochure presents description and specifications of maker's communication tape-monitor system for automatic recording of radio and phone intercommunication.—Magnecord Inc., 225 West Ohio St., Chicago, Ill.

Circle **493** on inquiry card.

TIME, FREQUENCY

Timing Devices. New 8-page illustrated Catalog 323 presents maker's line of electric timing devices. Includes interval timers, reset timers, elapsed time indicators, etc.—Haydon Mfg. Co., Inc., Torrington, Conn.

Circle **494** on inquiry card.

Time Switches. New 4-page illustrated Brochure 608.151.3 presents description, specifications and applications of maker's time switches for industrial installations.—General Controls, Glendale, Calif.

Circle **495** on inquiry card.

Counter. New 4-page illustrated brochure describes maker's automatic electric counters and how "FMC" record counter may be operated as a single counting unit or as a multiple bank of unlimited numbers giving a printed record of each count.—Food Machinery and Chemical Corp., Riverside, Calif.

Circle **496** on inquiry card.

Fractional Cycle Timer. New 2-page bulletin describes maker's "Model F216" fractional cycle timer designed to meet requirements of resistance welding when used for timing spot or seam welders.—Vacuum Tube Products, 506 S. Cleveland St., Oceanside, Calif.

Circle **497** on inquiry card.

Tachometer Generators. New 14-page brochure presents description and specifications of a.c.-d.c. tachometer generators.—Instrument Motors, P. O. Box 5, Acosta St., Stamford, Conn.

Circle **498** on inquiry card.

Tachometers. New 2-page Bulletins 132-13, 132-15, 132-12 describe makers line of tachometers, electric speed indicators, wind speed indicators, etc.—Westberg Mfg. Co., 144 S. Coombs St., Napa, Calif.

Circle **499** on inquiry card.

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GAGING

Extensometer Comparator. New 2-page Bulletin 4210 announces maker's new portable extensometer comparator for calibrating extensometers, compressometers, dial gages and similar devices.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle **500** on inquiry card.

Ramp Gages. New 58-page illustrated booklet discusses tape thread inspection with maker's direct-reading ramp gages.—Sheffield Corp., Dayton 1, Ohio.

Circle **501** on inquiry card.

Gage Selector. New slide-rule-type gage selector simplifies selection of proper pitch diameters for maker's thread plug or ring gages.—Sheffield Corp., Gage Div., Dayton, Ohio.

Circle **502** on inquiry card.

Electronic Gaging. New 2-page Bulletin 541 describes the measuring system used in maker's electronic dimensional gaging equipment.—Cleveland Instrument Co., 735 Carnegie Ave., Cleveland, Ohio.

Circle **503** on inquiry card.

Ring Gages. New 4-page illustrated brochure describes maker's "Boremaster" ring gages, reversible plain and thread plug gages, and "AGD" plain ring gages.—Size Control Co., 2500 W. Washington Blvd., Chicago 12, Ill.

Circle **504** on inquiry card.

Optical Gaging. New 4-page illustrated Bulletin 55SC describes shaft inspection by optical gaging.—Optical Gaging Products, Inc., 26 Forbes St., Rochester 11, N. Y.

Circle **505** on inquiry card.

Gaging. New 4-page brochure illustrates and describes maker's "Series 800" and "Series 900" micrometers that measure to 1/10,000 inch. New 2-page bulletin presents maker's vernier height gage, and maker's "Puppitast" universal test indicators.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

Circle **506** on inquiry card.

Linear Comparator. New 2-page Bulletin 192-53 presents description and specifications of maker's "M1177" linear comparator which reads direct to 0.001 mm. and is suitable for precise linear measurement of photographic records and spectrographic plates within its range of 150 mm.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.

Circle **507** on inquiry card.

Dial Comparator. New 2-page bulletin illustrates and describes maker's universal dial comparator for small parts inspection.—Mercury Supply Co., 410 Fairview, Elmhurst, Ill.

Circle **508** on inquiry card.

TORQUE, FORCE

Low-Force Dynamometer. New 2-page illustrated bulletin describes Swedish-made "spring balance", for measuring relay contact pressure and spring tensions within ranges of 0-10 and 0-350 gms.—Kay Instrument

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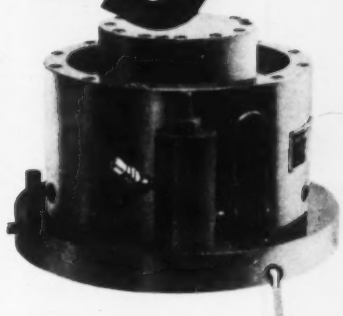
weighing and testing problems by



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NEW LITERATURE

Sales Co., Inc., 843 Tenth Ave., New York 19, N. Y.

Circle **509** on inquiry card.

Torque Limiters. New 8-page Catalog C14-54 presents design and operation information on maker's torque limiters for drivers and couplings.—Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

Circle **510** on inquiry card.

Weighing, Calibrating. New 2-page bulletin presents operation, application and specifications of maker's weighing and calibrating system.—Morehouse Machine Co., 233 W. Market St., York, Pa.

Circle **511** on inquiry card.

Clutches, Brakes. New 8-page catalog describes and illustrates maker's line of electro-magnetic clutches, brakes, and clutch breaks.—Magtrol Inc., 533 S. Niagara St., Tonawanda, N. Y.

Circle **512** on inquiry card.

VIBRATION

Balancing Machines. New 22-page Bulletin 49 describes maker's complete line of dynamic and static balancing machines including the horizontal and vertical models, and automatic crankshaft balancer.—Tinius Olsen Testing Machine Co., Easton Road, Willow Grove, Pa.

Circle **513** on inquiry card.

Balancing Machines. New 16-page booklet "A Practical Guide to Production Balancing" explains kinds of balance, condition of unbalance and presents maker's line of single plane, static balancing machines.—Micro-Poise Engineering & Sales Co., 14851 Grand River Ave., Detroit, Mich.

Circle **514** on inquiry card.

Vibration Control. New illustrated 4-page Bulletin 800 presents design features of all-metal mounting systems for mounting electronic equipment in missiles and aircraft.—Robinson Aviation, Inc., Teterboro, N. J.

Circle **515** on inquiry card.

Vibration Isolation Pads. New 2-page Bulletin F-127 and companion piece present specifications, applications and installation data for maker's vibration isolation material.—Hobsite Products Co., 308 Sussex St., Harrison, N. J.

Circle **516** on inquiry card.

RADIOACTIVITY

Nuclear Reactors. New set of bulletins describe solution type, homogeneous graphite, and pool-type nuclear reactors that company is prepared to design and construct for any qualified research or industrial group.—North American Aviation, Inc., Downey, Calif.

Circle **517** on inquiry card.

Gas Flow Counter. New 8-page No. 8 issue of "The Nucleus" features article on new automatic gas flow counter for weak beta emitters.—Nuclear Instrument & Chemical Corp., 233 W. Erie St., Chicago 10, Ill.

Circle **518** on inquiry card.

Windowless Flow Counter. New 2-page Bulletin 952 describes maker's "Model 952" windowless flow counter for geiger or proportional counting of solid samples in an inert atmosphere.—Atomic Instrument Co., Cambridge 39, Mass.

Circle **519** on inquiry card.

RADIOGRAPHY

Industrial X-Ray, etc. New 8-page Vol. 1, No. 1 issue of "Radiation Digest" presents short articles on industrial x-ray; applications of cathode rays in food, drug, chemical and grain fields; x-ray film processing; and others.—X-Ray Dept., General Electric Co., 4855 Electric Ave., Milwaukee, Wis.

Circle **520** on inquiry card.

X-ray Radiography. New 4-page Bulletin RC 114 explains x-ray head, control and other features of maker's "MG160" portable self-contained industrial x-ray radiographic unit.—North American Philips Co., Inc., Mount Vernon, N. Y.

Circle **521** on inquiry card.

TESTING, INSPECTION

Ultrasonic Gaging. New 8-page illustrated Bulletin 50-105 presents description, applications and specifications of maker's ultrasonic testing "Reflectoscope" and accessories.—Sperry Products, Inc., Danbury, Conn.

Circle **522** on inquiry card.

Helipot technical paper 339

Accuracy of Potentiometer Linearity Measurements

BY ROBERT McDONALD & IRVING HOGAN
Research and Development Division
Helipot Corporation

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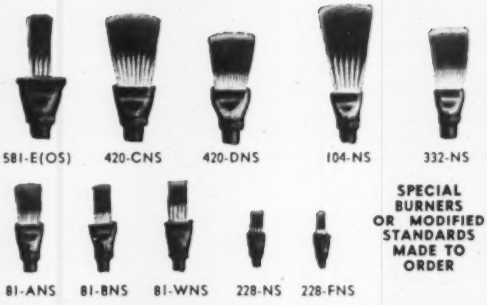

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For more information circle **122** on inquiry card.

Testing Sieves. New 6-page Bulletin 4-54-5M presents maker's line of standard testing sieves, market grade testing sieves and testing sieve shakers.—Newark Wire Cloth Co., 351-365 Verona Ave., Newark, N. J.

Circle **523** on inquiry card.

Indicating Extensometers. New 8-page illustrated Bulletin 4212 describes maker's line of dial indicating extensometers. Includes extensometers for sheet metal and wire, averaging extensometers, compressometers, deflectometers, and accessories.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle **524** on inquiry card.

Hardness Tester. New 4-page illustrated Bulletin 154 explains methods of testing hardness and drying time of coating materials using maker's hardness rocker.—Gardner Laboratory, Inc., Bethesda, Md.

Circle **525** on inquiry card.

Polariscope. New 4-page brochure describes maker's reflecting polariscope for determination of strain on glass and plastics.—R. Fuss, Inc., 39 West 60 St., New York, N. Y.

Circle **526** on inquiry card.

Tube Socket Tester. New 2-page bulletin describes maker's new "Gripmaster" a device for testing tube-socket specifications.—Size Control Co., 2500 W. Washington Blvd., Chicago 12, Ill.

Circle **527** on inquiry card.

Fiber Measurement. New bulletins illustrate and describe "Arealometer 142" (for measuring fineness and shape of fibrous material), and "Servo-Fibrograph 150" (for fiber-length testing by mills, buyers, merchants).—Special Instruments Laboratories, 312 W. Vine, Knoxville, Tenn.

Circle **528** on inquiry card.

Borescope. New 4-page illustrated brochure describes illuminated borescopes for industrial inspection of deep recessed areas otherwise inaccessable (cylinder walls, tubes, etc.)—National Electric Instrument Co., Inc., 92-21 Corona Ave., Elmhurst 73, N. Y.

Circle **529** on inquiry card.

OPTICAL

High-speed Cameras. New 8-page illustrated Booklet 1M-4-54 describes maker's "Fastax" high-speed motion-picture camera which photographs up to 16,000 frames per second.—Wollensak Optical Co., Rochester 21, N. Y.

Circle **530** on inquiry card.

Binocular Magnifier. New 4-page illustrated brochure describes maker's new "Magni-Focuser" 3-D binocular magnifier.—Edroy Products Co., 480 Lexington Ave., New York, N. Y.

Circle **531** on inquiry card.

Electron-multiplier Photometer. New 12-page Bulletin 1001EM presents features, applications and photographs of maker's new electron-multiplier photometer.—Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Phila., Pa.

Circle **532** on inquiry card.

Film Applicators. New 2-page Bulletin 151 describes and illustrates maker's film applicator for color matching and gloss and opacity comparisons.—Gardner Laboratory, Inc., Bethesda 14, Md.

Circle **533** on inquiry card.

Spherometers. New 4-page illustrated Circular 542 presents descriptions and specifications of maker's "Model L-1" and "Model P-1" ball-point spherometers.—Penn Optical and Instrument Co., 50 South San Gabriel Blvd., Pasadena, Calif.

Circle **534** on inquiry card.

Optical Test Bench. New 2-page brochure pictures and describes maker's universal bench, which features 30 components permitting instant assembly of a wide range of instrumentation for testing lenses, cameras, etc.—Meyer-Opticraft, Inc., 39 W. 60th St., New York 23, N. Y.

Circle **535** on inquiry card.

Synchronous Cameras. New catalog sheet describes synchronous motion picture cameras which can be used to record the operation of automatically controlled equipment.—Flight Research Engineering Corp., Richmond, Va.

Circle **536** on inquiry card.

Sound-on-film Camera. New brochure illustrates and describes "Cine-Voice" 16-mm. camera which "photographs" sound-track along one edge of film, providing sound at same film cost as silent pictures.—Berndt-Bach, Inc., Los Angeles 36, Calif.

Circle **537** on inquiry card.

ANALYTICAL

Spectrochemical Analysis. New 8-page Catalog V3-54 presents features and specifications of maker's standard and industrial models of the "Varisource," all-in-one excitation unit for precision spectrochemical analysis.—Jarrell-Ash Co., 26A Farwell St., Newtonville, Mass.

Circle **538** on inquiry card.

Spectrographs. New 10-page catalog presents maker's complete line of instruments for precision spectrochemical analysis.—Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Circle **539** on inquiry card.

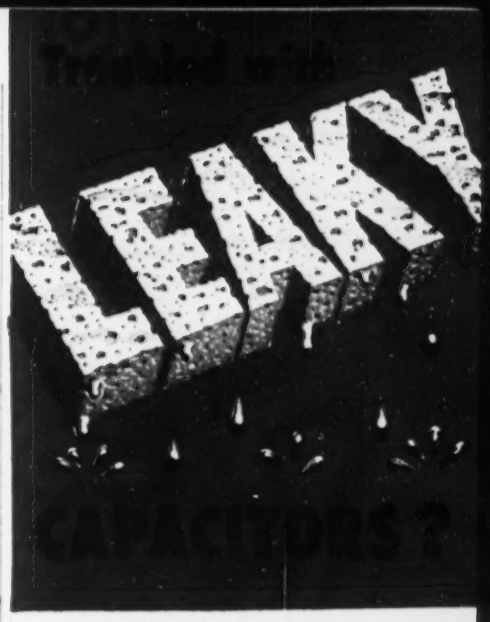
Raman Spectrography. New 20-page Catalog CH 334/2 illustrates and describes English made "E612" two-prism glass Raman spectrograph for use in photographic work or as a direct-reading instrument, and the "E517" and "E518" spectrographs for use with Raman spectra or for spectrographic recording of low-intensity sources.—Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

Circle **540** on inquiry card.

Gas Sampling. New 16-page issue of "Meters and Controls" features article on new aspirator, gas sampling system for high-dust-loading and high-temperature applications.—Meters and Controls., Inc., 444 N. La Salle St., Chicago, Ill.

Circle **541** on inquiry card.

Photometer. New 2-page illustrated brochure describes maker's light scattering photometer. Also differential refractometer and monochromatic



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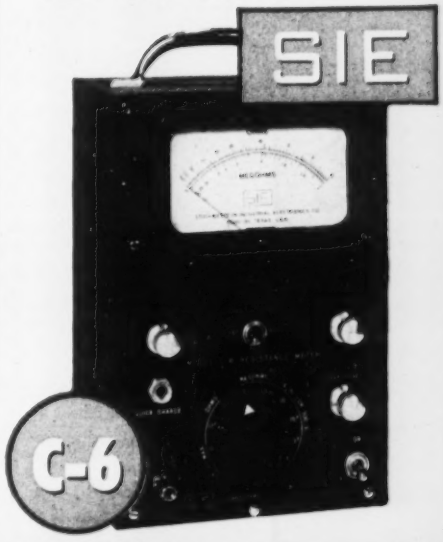

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NEW LITERATURE

light sources.—Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Phila., Pa.

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pH Control. New 12-page Bulletin 320 describes maker's instruments for industrial pH measurement and control.—Beckman Instruments, Inc., South Pasadena, Calif.

Circle **543** on inquiry card.

pH Meter. New 8-page Bulletin 342 describes and illustrates maker's "Model W" industrial pH meter—Beckman Instruments, Inc., Fullerton, Calif.

Circle **544** on inquiry card.

Water Testing. New 2-page Bulletin 5RE-54 illustrates and describes maker's kit for testing water hardness.—Hagan Corp., Pittsburgh 30, Pa.

Circle **545** on inquiry card.

Chromatography, Paper Electrophoresis. New 16-page Catalog AC-54 illustrates and describes maker's line of chromatography and paper electrophoresis apparatus.—Schaar and Co., 754 W. Lexington St., Chicago 7, Ill.

Circle **546** on inquiry card.

Microtome. New 16-page issue of "Norelco Reporter" (Vol. 1 No. 4) features article on a new microtome for ultra thin sectioning and application in electron microscopy.—North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.

Circle **547** on inquiry card.

Sulfur Titrator. New illustrated catalog sheet describes "Model ET-20" automatic sulfur titrator for iron and steel analyses.—Laboratory Equipment Corp., St. Joseph, Mich.

Circle **548** on inquiry card.

X-ray Analysis. New 4-page reprint "X-ray Diffraction Proves Valuable Research and Production Tool to Evaluate Properties of Metals" discusses three x-ray analysis methods for metals.—Research & Control Instruments Div., North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.

Circle **549** on inquiry card.

X-ray diffraction Questionnaire. New questionnaire for all users of X-ray diffraction is designed to help determine how fast the use of x-ray diffraction is growing and how broad are today's fields of application.—North American Philips Co., Inc., Mount Vernon, N. Y.

Circle **550** on inquiry card.

Spectrometer. New 4-page illustrated Data Sheet 10.16-8a describes maker's recording spectrometer for analysis in industrial laboratories.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **551** on inquiry card.

Infrared Source. New 2-page illustrated Bulletin ODC-409 presents applications, description and specifications of maker's "Type RS-1A" and "TC-2A" infrared reference source designed as "Secondary standard of black body radiation."—Olympic Development Co., 30 Commerce Rd., Stamford, Conn.

Circle **552** on inquiry card.

Photometer. New 2-page bulletin presents description, applications and specifications of maker's ultraviolet photometer and accessories for measuring toxic vapors.—Harold Kruger Instruments, P. O. Box 164, San Gabriel, Calif.

Circle **553** on inquiry card.

X-ray diffraction Powder Camera. New 2-page brochure describes maker's "Model HC-101" high-temperature x-ray diffraction powder camera for investigations of substances at temperatures to 1000 deg. C.—Central Research Laboratories, Inc., Red Wing, Minn.

Circle **554** on inquiry card.

Paper Electrophoresis. New 10-page Brochure, RS-254 describes and illustrates maker's line of paper electrophoresis equipment, power supplies and accessories.—Research Specialties Co., 1148 Walnut St., Berkeley, Calif.

Circle **555** on inquiry card.

Chlorine, pH Tests. New Service Bulletin G-1-54 illustrates and describes procedures and comparator systems for testing chlorine, pH, phosphate, chromate, etc., covers accessories, prices.—LaMotte Chemical Products Co., Towson, Baltimore 4, Md.

Circle **556** on inquiry card.

Diffraction Gratings. New 28-page illustrated monograph Booklet D-261, presents theory, principles, and manu-

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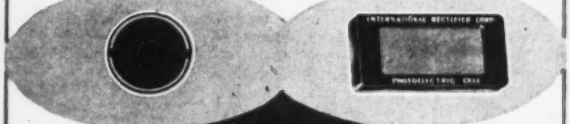

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facture of diffraction gratings; also contains listing of 100 plane reflectance gratings and 20 plane transmission gratings.—Bausch & Lomb Optical Co., Rochester 2, N. Y.

Circle **557** on inquiry card.

LABORATORY

Laboratory Planning. New 22-page "Better Laboratory Planning" Bulletin 35-E discusses planning the laboratory, purchasing equipment, and bidding procedure.—Scientific Apparatus Makers Association, 20 Wacker Dr., Chicago, Ill.

Circle **558** on inquiry card.

Lab Equipment. New 8-page issue of "Palo Retort" presents descriptions and illustrations of distributor's line of laboratory supplies including a viscosity conversion chart.—Palo Laboratory Supplies, Inc., 81 Reade St., New York, N. Y.

Circle **559** on inquiry card.

Lab Furnaces. New 6-page illustrated brochure presents maker's tube furnaces, box and muffle type furnaces, "Combustron" and "Carbotrane." Also lists available bulletins and catalogs on laboratory apparatus. —Burrell Corp., 2223 Fifth Ave., Pittsburgh, Pa.

Circle **560** on inquiry card.

Lab Apparatus. New 64-page supplement to Catalog J-15D describes and illustrates maker's line of scientific instruments and laboratory supplies.—Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.

Circle **561** on inquiry card.

Lab Equipment. New 20-page issue of "Burrell Announcer" presents maker's line of scientific laboratory equipment and features article on the Armed Forces Medical Library.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Circle **562** on inquiry card.

Lab Equipment. New 20-page Catalog 5201 describes Lindberg lab apparatus (furnaces, hot plates, combustion units, volumetric carbon determinator, automatic timer, flow meter) available from—Boder Scientific Co., 719 Liberty Ave., Pittsburgh 22, Pa.

Circle **563** on inquiry card.

Glassware Washer. New 4-page illustrated bulletin describes maker's self-contained glassware washing machine for automatic washing of all types, sizes and shapes of laboratory glassware.—Rochester Scientific Co. 183 St. Paul St., Rochester, N. Y.

Circle **564** on inquiry card.

Lab Equipment. New 8-page illustrated brochure describes maker's line of research laboratories, hospitals and pharmaceutical plants.—Popper & Sons, Inc., 300 Fourth Ave., New York 10, N. Y.

Circle **565** on inquiry card.

Phase Research Microscopes. New 4-page illustrated brochure A-9 presents features, construction and description of maker's "No. 8" phase microscopes for phase and bright-field microscopy; 4-page brochure C3 pre-

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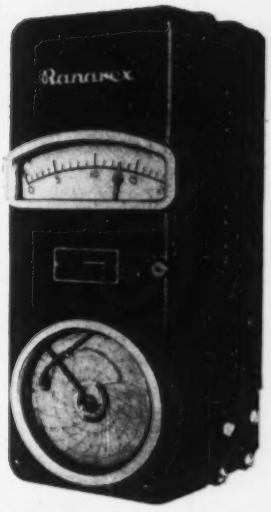

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NEW LITERATURE

sents "No. 5" research microscope.—American Optical Co., Buffalo 15, N. Y.

Circle **566** on inquiry card.

Microscope Illuminators. New 2-page Microscope Lamp Sheet 1 presents features and operation data on maker's microscope illuminators.—The Head Line Co., Flushing 66, N. Y.

Circle **567** on inquiry card.

Laboratory Mills, Carts. New illustrated brochure gives features, limitations and prices of "Labconco" mills and lab carts.—Laboratory Construction Co., 1115 Holmes St., Kansas City, Mo.

Circle **568** on inquiry card.

Microscopes. New 8-page and 2-page brochures illustrate and describe maker's line of microscopes, accessories, and "Model A" wide-field microscope.—Testa Mfg. Co., 418 S. Pecan St., Los Angeles, Calif.

Circle **569** on inquiry card.

Scientific Glassware. New 52-page catalog illustrates and describes maker's large line of scientific glassware and special scientific glass apparatus.—Delmar Scientific Laboratories, 1551 N. Cicero Ave., Chicago, Ill.

Circle **570** on inquiry card.

Microscopes. New 24-page catalog describes maker's line of laboratory microscopes and hemoglobin-determination instruments.—American Optical Co., Buffalo, N. Y.

Circle **571** on inquiry card.

Polarizing Microscopes. New 6-page Brochure D-130-15 presents maker's "Models: Series S, I, and M" polarizing microscopes with "Dynoptic" ball-bearing stand, and accessories.—Bausch & Lomb Optical Co., Rochester, N. Y.

Circle **572** on inquiry card.

Freezing-point-depression Apparatus. New 2-page Bulletin 2248 presents description and features of maker's freezing-point apparatus for cryoscopic osmotic activity determinations of 1-cc. samples of aqueous solutions.—American Instrument Co., Inc., Silver Spring, Md.

Circle **573** on inquiry card.

AUDIO, ITV

ITV Camera. New 2-page bulletin presents description, features and specifications of maker's "Model PA-930" industrial television camera.—General Precision Laboratory Inc., Pleasantville, N. Y.

Circle **574** on inquiry card.

Explosion-proof ITV Monitor. New 2-page bulletin describes and illustrates maker's new "Safeye" explosion-proof television monitor for use in hazardous locations.—Decade Instrument Co., Box 153, Caldwell, N. J.

Circle **575** on inquiry card.

TV Camera System. New 4-page brochure describes system comprising three basic units: camera, camera control, and synchronizer-monitor, for industrial and commercial use.—Kalbfell Laboratories, Inc., 1090 Morena Blvd., San Diego, Calif.

Circle **576** on inquiry card.

Radio, TV Electronics. New 8-page illustrates and describes distributor's line of radio, television and high-fidelity equipment.—Newark Electric Co., 223 West Madison St., Chicago 6, Ill.

Circle **577** on inquiry card.

Radio, TV, Electronics. New 56-page Supplement 139 describes and illustrates distributor's line of radio, television and electronics equipment.—Allied Radio, 100 N. Western Ave., Chicago, Ill.

Circle **578** on inquiry card.

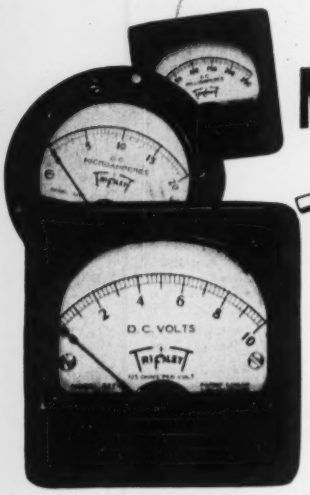
Hi-Fi Equipment. New illustrated brochure presents description of distributor's full line of electronic and sound equipment including hi-fi AM-FM receivers, capacitors, transformers, etc.—Hudson Radio and Television Corp., 48 W. 48 St., New York, N. Y.

Circle **579** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

30-Mc. Attenuator. New 4-page illustrated bulletin describes 30-Mc. attenuator for bench use as linear standard of attenuation in range 25-35 Mc.—Airborne Instruments Laboratory, Mineola, L. I., N. Y.

Circle **580** on inquiry card.



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Signal Generator. New 4-page issue of "hp Journal" (Vol. 5, No. 5-6) discusses maker's new "Model 620A SHF" signal generator with frequency range from 7,000 to 11,000 Mc.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **581** on inquiry card.

Impedance. New 4-page issue of "Technician's Timesaver" features article on use of maker's "Model 480 Genescope" to check impedance mismatches.—Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

Circle **582** on inquiry card.

Portable Instruments. New 4-page illustrated Circular A-20-C describes maker's "Model 622" d-c. instruments, thermo instruments, and rectifier type a-c. instruments.—Weston Electrical Instrument Corp., Newark, N. J.

Circle **583** on inquiry card.

Panel Instruments. New 28-page Circular A-7-D describes and illustrates popular ranges and styles of maker's line of panel instruments.—Weston Electrical Instrument Corp., Newark, N. J.

Circle **584** on inquiry card.

Electronic Test Instruments. New 8-page Circular R-31-H presents maker's line of service instruments. Includes tube analyzers, tube checkers, high-frequency electronic analyzers, industrial circuit testers, etc.—Weston Electrical Instrument Corp., Newark, N. J.

Circle **585** on inquiry card.

Panel Instruments. New 8-page Catalog N1 describes and illustrates maker's line of panel electrical instruments.—Burlington Instrument Co., Burlington, Iowa.

Circle **586** on inquiry card.

Soil Resistivity Meter. New 2-page illustrated Bulletin 105A describes instrument which reads directly soil resistivity to 30,000 ohm-cm.—Associated Research, Inc., 3767 W. Belmont Ave., Chicago, Ill.

Circle **587** on inquiry card.

Battery Charger. New 6-page Bulletin 203S presents description, applications and operation of maker's new battery charger with charging rate of .05 to 2.0 amperes.—Automatic Switch Co., 385-T Lakeside Ave., Orange, N. J.

Circle **588** on inquiry card.

Cathode Follower. New 2-page bulletin presents description and applications of maker's "M1523" low-impedance cathode follower.—Walkirt Co., 145 West Hazel St., Inglewood, Calif.

Circle **589** on inquiry card.

Plug-in Circuits. New 4-page Brochure 108-10-3 describes maker's line of resin encapsulated, moisture and vibration proof plug-in units.—Walkirt Co., 145 West Hazel St., Inglewood, Calif.

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Magnetic Amplifiers. New 6-page Brochure SS 235 presents specifications and description of maker's magnetic amplifiers. Includes push-pull magnetic amplifiers, adjustable magnetic servo amplifiers, saturable transformers, magnetic voltage regulators

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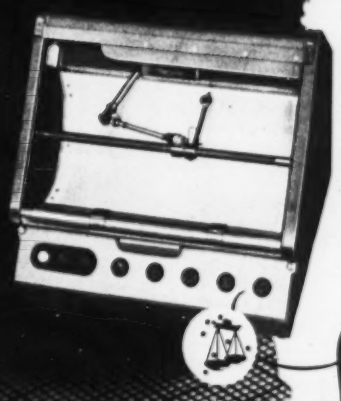

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NEW LITERATURE

and variable-speed drives.—Magnetic Amplifiers, Inc., 632 Tinton Ave., New York, N. Y.

Circle **591** on inquiry card.

Chopper Amplifier. New 2-page Bulletin 2500-953 presents specifications and diagrams of maker's "Model 300B" chopper amplifier for microvolt signal sources at frequencies of 0 to 200 cps.—Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.

Circle **592** on inquiry card.

VSWR. New 2-page Bulletin 106 presents description, specifications and theory of operation of maker's new "Model 136A" meter for measurement of standing-wave reflection coefficient (VSWR).—Sierra Electronic Corp., San Carlos, Calif.

Circle **593** on inquiry card.

Curve Plotter, Color Generator. New set of bulletins describe maker's transistor curve plotter, radar noise figure measuring set, pulsed-carrier generator, gain measuring set, decade switched oscillator, etc. Announces new "Uni-Chrome Chromabar" color generator.—Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle **594** on inquiry card.

Oscilloscopes. New 24-page Booklet 25410C describes and illustrates maker's line of cathode-ray oscilloscopes.—Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio.

Circle **595** on inquiry card.

Null Indicator. New 2-page Data Sheet 10.0-12 presents description, characteristics and operating principle of maker's portable null indicator.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **596** on inquiry card.

Electrical Instruction Kits. New 4-page bulletin describes and illustrates maker's electrical instruction equipment and discusses applications in teaching electricity.—Crow Electri-Craft Corp., 1102 Shelby St., Vincennes, Ind

Circle **597** on inquiry card.

Decade Shunt. New 2-page bulletin describes maker's "Model 2008" decade shunt which provides 10 current ranges, permitting full-scale readings over range of 2 milliamperes down to 2 micromicroamperes.—Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.

Circle **598** on inquiry card.

Power Amplifier. New 4-page Laboratory Report 10 presents description and applications of maker's "Type 511-A" lab power amplifier, with push-pull 6L6 output, negligible distortion, and phase-shift compensation.—Technology Instrument Corp., 531 Main St., Acton, Mass.

Circle **599** on inquiry card.

Tube Tester. New 4-page brochure describes and illustrates maker's "Model 700" laboratory tube tester with all voltages variable and metered.—Hickock Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio.

Circle **600** on inquiry card.

Square-Wave Generator. New 2-page Preliminary Spec Sheet describes maker's new "Model 183" square-wave generator with frequency range for 10 cps. to 1Mc. continuously variable in decade steps.—New London Instrument Co., P. O. Box 189, New London, Conn.

Circle **601** on inquiry card.

Linearity Checker. New 2-page Bulletin A14 presents maker's new "Lin-A-Chek," a linearity checker for testing instruments where precise electrical measurements are required.—Micrometrical Development Corp., 2821 S. State St., Ann Arbor, Mich.

Circle **602** on inquiry card.

Sound Measurement. New 12-page illustrated brochure presents description and applications of maker's line of sound-measurement instruments—sound-level meter, survey meter, sound analyzer and octave-band noise analyzer.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **603** on inquiry card.

Pulse Generator. New 8-page issue of "General Radio Experimenter" (Vol. 28, No. 10) features article on "A Pulse Generator for the Unit Line" describing maker's "1217-A" unit pulser.—General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.

Circle **604** on inquiry card.

Ground Detector. New 8-page illustrated booklet presents features and principles of operation of maker's "Faultfinder" for location of grounds on energized power circuits.—Parr

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Mfg. Corp., 44 Austin St., Newark 5, N. J.

Circle **605** on inquiry card.

Microwave Dielectrometer. New 4-page brochure presents description and specifications of maker's microwave dielectrometer for measurement of dielectric constant and loss.—Central Research Laboratories, Inc., Red Wing, Minn.

Circle **606** on inquiry card.

Balanced Modulator. New 8-page issue of "Experimenter" (Vol. 28, No. 11) features article on maker's "Type 1000-P7" balanced modulator for pulse applications.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **607** on inquiry card.

Electronic Instruments. New 8-page brochure describes and illustrates latest additions to maker's line of electronic instruments, including oscillators, power amplifiers, and power supplies.—Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge, Mass.

Circle **608** on inquiry card.

Oscilloscope Preamplifier. New 2-page Bulletin VSB-20 describes and illustrates maker's wide-band d-c. oscillograph preamplifiers.—Volkers & Schaffer Mfg., Corp., Box 996, Schenectady, N. Y.

Circle **609** on inquiry card.

Circuit Loading Errors. New 2-page issue of "Keithley Engineering Notes" (Vol. 1 No. 2) features article on "A Way to Reduce Circuit Loading Errors."—Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.

Circle **610** on inquiry card.

VOR Omnirange. New 12-page illustrated catalog describes maker's new line of 50- and 200-watt VOR transmitting installations for municipal, commercial, and private fields.—Collins Radio Co., Cedar Rapids, Iowa.

Circle **611** on inquiry card.

Comparison Bridge. New Vol. 28 No. 9 issue of "Experimenter" presents illustrated article on "Type 1604-B" production-test instrument.—General Radio Co., Cambridge 39, Mass.

Circle **612** on inquiry card.

Oscilloscopes. New 8-page brochure describes maker's new "VS-900" series of oscilloscopes with high a-c. sensitivity and freedom from distortion.—Volders & Schaffer Mfg. Corp., Box 996, Schenectady, N. Y.

Circle **613** on inquiry card.

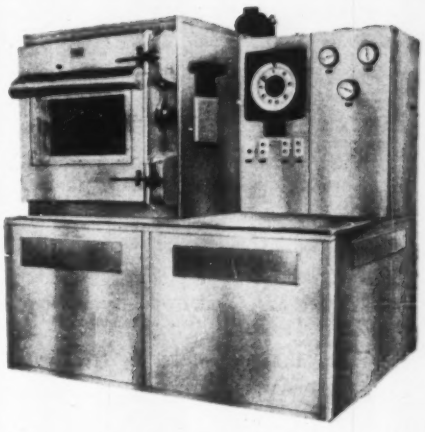
Kilovoltmeter. 2-page illustrated Bulletin 154 describes "Models 2006-7" electrometer voltage dividers which clip onto maker's electrometers to extend voltage ranges permitting measurement to 20,000 volts.—Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.

Circle **614** on inquiry card.

Microwave Mixer. New 6-page Technical Bulletin T-2600 presents theoretical and design data helpful in choosing proper waveguide mixer for particular use.—Dept. A, Airtron, Inc., 1103 W. Elizabeth Ave., Linden, N. J.

Circle **615** on inquiry card.

TEST CHAMBERS



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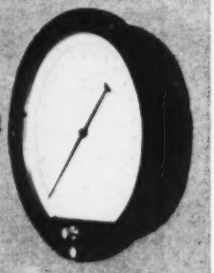

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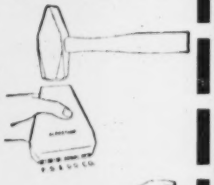

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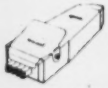

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For more information circle **138** on inquiry card.

NEW LITERATURE

Electronic Test Equipment. New 12-page illustrated Catalog 54-A describes sweep and signal generators, oscillators, transmission measuring set, and other test instruments.—The Clough-Brengle Co., Dept. I, 6014 Broadway, Chicago 40, Ill.

Circle **616** on inquiry card.

Microwave Test Equipment. New Catalog FXR describes and illustrates maker's full line of precision microwave test equipment. Also antenna pattern analyzers, pulse modulators, and waveguide components.—F-R Machine Works, Inc., 44-14 Astoria Blvd., L. I. C., N. Y.

Circle **617** on inquiry card.

Insulation Tester. New 2-page bulletin describes and illustrates maker's "Model 101" high-voltage tester featuring buzzer signal on breakdowns, grounds and shorts.—Slaughter Co., 1700 Nicklin Ave., Piqua, Ohio.

Circle **618** on inquiry card.

Appliance Rectifier. New card pictures and describes maker's appliance rectifier that converts a.c. to d.c.—Gates Electric Co., 65 West Broadway, New York, N. Y.

Circle **619** on inquiry card.

UHF Test Equipment. New 4-page illustrated brochure presents maker's UHF wavemeter, oscillator balun and transformer.—Linear Equipment Laboratories, Inc., Brightwater Place, Massapequa, L. I., N. Y.

Circle **620** on inquiry card.

Null Detection. New 2-page bulletin describes use of maker's null meter model "100A" for nulling bridges, potentiometers, synchros, resolvers and allied devices.—Industrial Test Equipment Co., 55 East 11 St., New York 3, N. Y.

Circle **621** on inquiry card.

Electrical Maintenance, Safety. New 64-page Catalog 29 describes and illustrates maker's large line of commutator, motor, and generator maintenance equipment, electrical and mechanical maintenance, metal working tools, flexible shaft machines, and safety equipment.—Martindale Electric Co., Box 617, Edgewater Branch, Cleveland, Ohio.

Circle **622** on inquiry card.

Pulse-forming Networks. New 2-page Bulletin 108 presents description, operating principle, applications and construction details of maker's pulse-forming networks and delay lines.—Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.

Circle **623** on inquiry card.

Null Meter. New 2-page illustrated brochure presents operating principles, features and specifications of maker's "Model 100A" null meter.—Industrial Test Equipment Co., 55 East 11 St., New York 3, N. Y.

Circle **624** on inquiry card.

Interference Filters. New 4-page Bulletin 107 illustrates and describes 11 types of r-f. interference filters and noise-suppression capacitors.—Mica-

mold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.

Circle **625** on inquiry card.

RESISTORS, POTENTIOMETERS

Resistors. New 22-page catalog 54 describes and illustrates maker's rheostats, switches, controls, and resistors.—Clarostat Mfg. Co., Inc., Dover, N. H.

Circle **626** on inquiry card.

Wire-wound Resistors. New 2-page illustrated Bulletin L-30 presents maker's new "P" type encapsulated precision wire-wound resistors.—Shallcross Mfg., Co., Collingdale, Pa.

Circle **627** on inquiry card.

High-frequency Resistors. New 2-page Bulletin F-3 presents construction, applications, and specifications of maker's high-frequency resistors.—International Resistance Co., 401 N. Broad St., Phila., Pa.

Circle **628** on inquiry card.

Potentiometers. New 2-page illustrated bulletin presents features and specifications of maker's new "HP-300" series 3-inch high-resolution potentiometers.—DeJur-Amsco Corp., 45-01 Northern Blvd., L. I. C., N. Y.

Circle **629** on inquiry card.

Potentiometers. New 4-page illustrated bulletin presents features, specifications, and applications of maker's "Series L-400" fully enclosed precision ganging potentiometers.—DeJur-Amsco Corp., 45-01 Northern Blvd., L. I. C., N. Y.

Circle **630** on inquiry card.

Resistors. New 30-page catalog describes and illustrates maker's line of precision wire-wound resistors.—Daven Co., 191 Central Ave., Newark, N. J.

Circle **631** on inquiry card.

Slide-wire Rheostats. New 4-page Bulletin 551 pictures and describes "Standco" line of slide-wire rheostats with graduated percentage scale.—Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y.

Circle **632** on inquiry card.

Precision Resistors. New 2-page leaflet describes maker's "K-F" series of nine resistor types providing standard values over the range of 0.1 ohm to 1 megohm in accuracies from 1 to 0.1 percent.—K-F Development Co., Redwood City, Calif.

Circle **633** on inquiry card.

Precision Resistors. New 6-page bulletin presents performance, characteristics, and construction of maker's deposited-carbon precision resistors.—Campbell Industries Inc., 3806 St. Elmo Ave., Chattanooga 9, Tenn.

Circle **634** on inquiry card.

Rheostats. New 2-page Bulletin 1116 presents features, applications and construction of maker's "Vitrohm" ring-type rheostats.—Ward Leonard Electric Co., Mount Vernon, N. Y.

Circle **635** on inquiry card.

Microfriction Potentiometer. New 4-page illustrated bulletin describes for-

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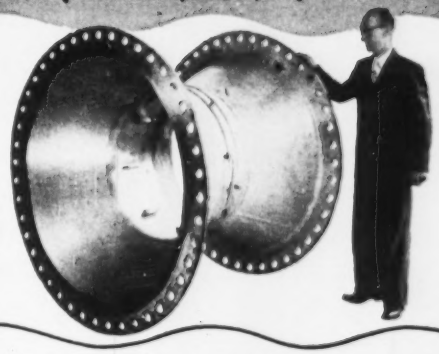

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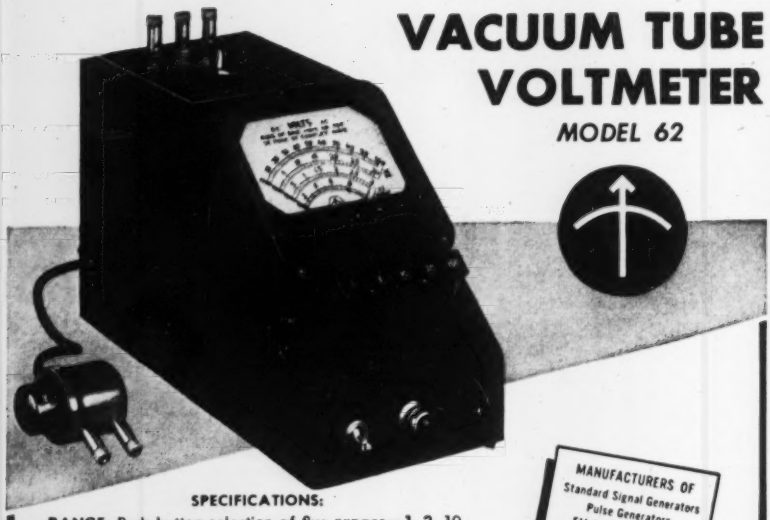

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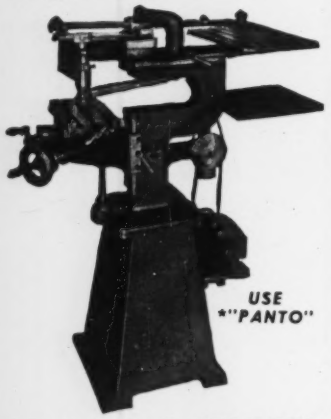

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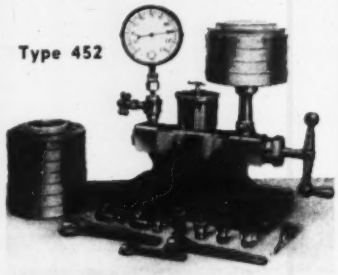

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NEW LITERATURE

eign-made microfriction potentiometer for remote control, instrumentation, servomechanisms, computers, etc.—F. H. Paul & Stein Bros., Inc., 100 Gold St., New York, N. Y.

Circle **636** on inquiry card.

Precision Potentiometer. New 4-page brochure presents description and specifications of maker's "Type A" precision potentiometer.—Jarvis Electronics Corp., 6058 W. Fullerton Ave., Chicago, Ill.

Circle **637** on inquiry card.

SWITCHES, RELAYS

Frequency-sensitive Relay. New 8-page Bulletin 33 presents description, specifications and diagrams of maker's new line of resonant-reed frequency-sensitive relays.—James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.

Circle **638** on inquiry card.

Switches. New 8-page Bulletin L-31 describes and illustrates maker line of precision push-button and rotary switches.—Shallcross Mfg., Co., Collingdale, Pa.

Circle **639** on inquiry card.

Mercury Relays. New 6-page bulletin describes maker's new hermetically-sealed, explosion-proof, hydrogen-filled heavy-duty mercury relays; 4-page Catalog 154 covers plunger-type mercury relays.—Ebert Electronics Corp., 212-26 Jamaica Ave., Queens Village 28, N. Y.

Circle **640** on inquiry card.

Precision Relays. New 42-page Catalog L15M54 describes and illustrates maker's line of precision relays, including midget relays, radio and high-frequency relays, etc.—Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif.

Circle **641** on inquiry card.

Crossbar Switch. New 2-page brochure presents applications, function, operation and construction of maker's new HF crossbar switch for interconnecting groups of circuits with other groups in any combination. New 8-page brochure presents applications of "Type P" crossbar in computers, monitoring, etc.—James Cunningham Son & Co., Inc., Dept. P, 13 Canal St., Rochester 8, N. Y.

Circle **642** on inquiry card.

Limit Switch. New set of Bulletins 111AS describe and illustrate maker's machine tool limit switch.—Square D Co., 4041 N. Richards St., Milwaukee, Wis.

Circle **643** on inquiry card.

Limit Switch. New 4-page illustrated Bulletin LS54A describes new heavy-duty "Loxswitch" limit switch with trigger-type mechanism.—Dept. L, R. B. Denison Mfg. Co., 102 St. Clair Ave., N. W., Cleveland 13, Ohio.

Circle **644** on inquiry card.

Low-voltage Switchgear. New 34-page Bulletin 200 presents descriptions specifications and applications of maker's line of low-voltage switchgear.—Continental Electric Equipment Co., Box 1055, Cincinnati 1, Ohio.

Circle **645** on inquiry card.

Relays. New 16-page Catalog GS presents maker's line of relays; includes polar relays, latching relays, time-delay relays, telephone relays, etc.—Kurman Electric Co., 35-18 37th St., L. I. C., N. Y.

Circle **646** on inquiry card.

AC Solenoids. New 8-page brochure presents description, and specifications of maker's "100" and "200" series a-c. solenoids.—West Coast Electrical Mfg., Los Angeles 61, Calif.

Circle **647** on inquiry card.

Magnetic Relays. New 4-page illustrated Bulletin 560-A presents maker's line of open and hermetically sealed a-c. and d-c. magnetic relays.—R-B-M Div., Essex Wire Corp., Logansport, Ind.

Circle **648** on inquiry card.

Push-button Units. New 4-page Bulletin 5403 describes maker's push button units of molded thermal setting plastic.—Furnas Electric Co., Batavia, Ill.

Circle **649** on inquiry card.

ELECTRONIC COMPONENTS

Quartz Crystals. New 6-page illustrated Brochure ECQ-1 explains new approach to method of specifying the maker's custom-made quartz crystals.—General Electric Co., Germanium Products, Syracuse, N. Y.

Circle **650** on inquiry card.

Toroids, Transformers. New 2-page brochure illustrates and describes maker's subminiature toroids and miniature transistor transformers.—Freed Transformer Co., Inc., 1718 Weirfield St., Brooklyn, N. Y.

Circle **651** on inquiry card.

"Silvercel" Application Guide. New application-guide rotating-disc card is indicator for selection of the most suitable "Silvercel" battery for any given application requirement.—Yardney Electric Corp., 105 Chambers St., New York, N. Y.

Circle **652** on inquiry card.

Choppers. New 12-page Bulletin 103 and 4-page bulletin describe and illustrate maker's choppers and explain theory and applications.—Airpax Products Co., Middle River, Baltimore, Md.

Circle **653** on inquiry card.

Germanium Diodes. New 2-page Bulletin N-1 presents description, construction and applications of maker's new "Type 1N" series germanium diodes.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle **654** on inquiry card.

Electronic Components. New 4-page issue of "Engineering News" (Vol 7 No. 2) contains articles on use of maker's connectors in oscilloscopes, pin-setting machines, and other products.—American Phenolic Corp., 1830 South 54 St., Chicago 50, Ill.

Circle **655** on inquiry card.

Tape-wound Cores. New 20-page Catalog TWC-100 describes and illustrates maker's line of tape-wound

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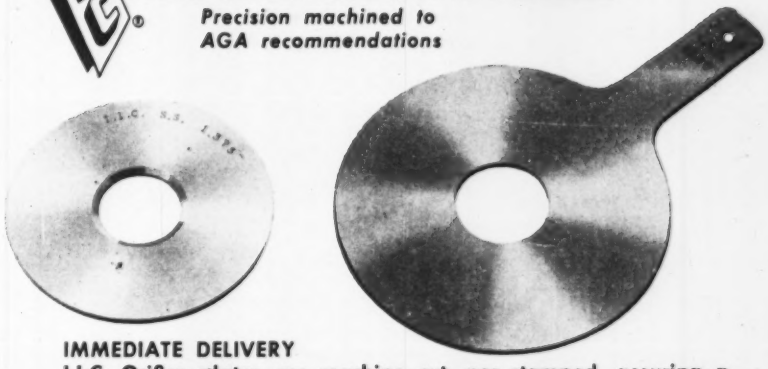

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2	1.80	2.40	1.50	2	3.60	4.80	1.50
3	2.00	2.70	1.50	3	4.35	5.60	1.50
4	2.15	3.00	1.50	4	4.80	6.35	1.50
6	3.00	5.00	1.50	6	5.60	7.15	1.50
8	3.90	7.10	2.50	8	6.40	11.10	2.50
10	4.50	10.30	2.50	10	7.60	14.80	2.50
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14	5.10	16.20	2.50	14	10.80	20.75	2.50
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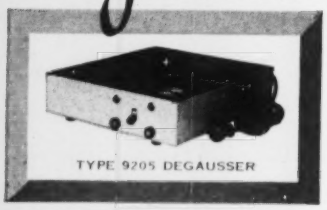

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NEW LITERATURE

cores, powder cores and magnetic laminations.—Magnetics Inc., Butler, Pa.

Circle **656** on inquiry card.

Pipe-line Anodes. New 4-page brochure describes maker's magnesium anodes and carbon ground anodes for corrosion protection problems. Also article on corrosion in automobile cases.—Pipe Line Anode Corp., Tulsa, Okla.

Circle **657** on inquiry card.

Printed Circuits. New 4-page Bulletin 106 presents photographs and drawings of maker's printed circuits and patterns.—Insulated Circuits, Inc., Belleville, N. J.

Circle **658** on inquiry card.

Capacitors, Filters. New 48-page Catalog AC-4 describes and illustrates maker's full line of capacitors and filters.Includes electrolytic capacitors, paper capacitors, metalized paper capacitors.—Astron Corp., 255 Grant Ave., East Newark, N. J.

Circle **659** on inquiry card.

Color TV Picture Tubes. New chart. illustrates the three most important color picture tube types: flat aperture mask, curved aperture mask and field deflection.—Sylvania Electric Products Inc., 1740 Broadway, New York, N. Y.

Circle **660** on inquiry card.

Quartz Crystal Units. New 4-page illustrated brochure describes maker's quartz crystal units, pressure mounted or plated in fundamental and overmode types.—Reeves Hoffman Corp., Cherry & North St., Carlisle, Pa.

Circle **661** on inquiry card.

Plastic-film Capacitors. New 4-page Bulletin 154 describes maker's "Type MH" miniature plastic-film close-tolerance capacitors.—Electronic Fabricators, Inc., 682 Broadway, New York, N. Y.

Circle **662** on inquiry card.

Selenium Rectifiers. New 24-page Bulletin 6.400 presents characteristics, operation and applications of maker's selenium rectifiers. Includes principles and basic circuit applications.—Fansteel Metallurgical Corp., North Chicago, Ill.

Circle **663** on inquiry card.

The Office National d'Etudes et de Recherches aéronautiques, 55 Bd Malesherbes, Paris, holder of U. S. Patent No. 2,597,149 dated May 20, 1952: "Ultrahigh-frequency magnetometer" manufacturers would like to deal with constructors in the United States through licensing.

DC-AC Choppers. New set of Bulletins 370, 371 and 238E describe and illustrate maker's a-c. and d-c. choppers, including applications in computers, microvoltmeters, etc.—Stevens-Arnold, Inc., 22 Elkins St., S. Boston, Mass.

Circle **664** on inquiry card.

Printed Circuits. New 8-page bulletin describes function application and fabrication of maker's printed circuits and allied electronic subassemblies.—Photocircuits Corp., Glen Cove, N. Y.

Circle **665** on inquiry card.

Printed Circuits. New 14-page issue of "Progress Thru Research" (Vol. 8, No. 3) features article on printed circuits.—General Mills, Chemical Div., Kankakee, Ill.

Circle **666** on inquiry card.

Pulse Transformers. New 2-page Bulletin 502 presents description and diagrams of maker's "Type 10 Z" and "20 Z" hermetically sealed pulse transformers.—Sprague Electric Co., North Adams, Mass.

Circle **667** on inquiry card.

Transformers. New 28-page Catalog TR-54 describes and illustrates maker's line of transformers—filament transformers, power transformers, etc.—Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

Circle **668** on inquiry card.

Twin Triode Amplifier. New 4-page brochure presents maker's "6BQ7A" miniature medium-mu twin-triode amplifier.—Sylvania Electric Products Inc., Emporium, Pa.

Circle **669** on inquiry card.

Electronic Parts. New 6-page catalog presents maker's line of antennas, coils, video clears, lock switches, etc. —Clum Mfg. Co., Milwaukee, Wis.

Circle **670** on inquiry card.

Electric Wiring. New 20-page Catalog 1-54 describes and illustrates maker's full line of wiring devices for industrial and commercial wiring—switches, outlets, etc.—Slater Electric & Mfg. Co., Woodside, N. Y.

Circle **671** on inquiry card.

Transistors. New 10-page brochure (Folder plus inserts) contains data sheets describing maker's "2N47," "2N49," and "2N62" p-n-p germanium junction transistors.—Philco Corp., Phila. 44, Pa.

Circle **672** on inquiry card.

Germanium Diodes. New data sheet describes "CK739" and "CK742" gold-bonded germanium junction diodes for magnetic computer and similar applications.—Raytheon Mfg. Co., Newton, Mass.

Circle **673** on inquiry card.

Electrical Test Clips. New 6-page folder describes and pictures test clips which take any size leads in testing motors by direct or remote hook-up.—Rapid Specialties Co., 325 W. Huron St., Chicago 10, Ill.

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Variable Transformers. New 18-page Catalog Form 1053 illustrates and describes "Adjust-A-Volt" vari-

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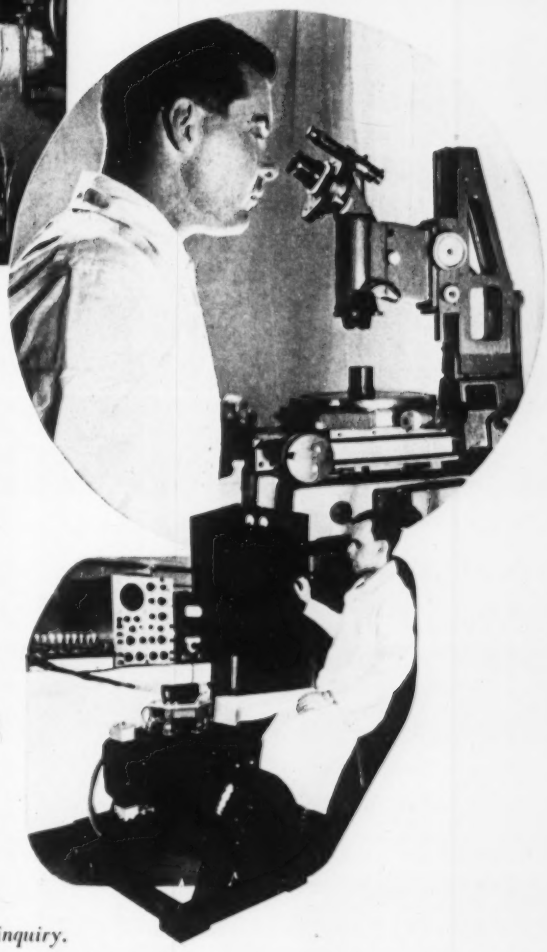

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able transformers in single, gang units, and autotransformer types.—Standard Electrical Products Co., 2240 E. Third St., Dayton 3, Ohio.
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Microwave Rotary Joint. New 2-page Bulletin RJ-1 illustrates and describes new high-power rotary joint.—Microwave Development Labs, Inc., 220 Grove St., Waltham 54, Mass.
Circle 676 on inquiry card.

Temperature-limited Diodes. New 4-page illustrated bulletin presents electrical and mechanical specifications of maker's line of temperature-limited diodes having stable emission characteristics.—Thermosen, Inc., 361 W. Main St., Stamford, Conn.
Circle 677 on inquiry card.

Cross Guide Coupler. New 2-page Bulletin DC-1 describes and illustrates maker's "Model X 126E" cross guide coupler.—Microwave Development Labs., Inc., 220 Grove St., Waltham 54, Mass.
Circle 678 on inquiry card.

Instrument Transformers. New 30-page Catalog 131-000 describes and illustrates maker's line of current and potential transformers for indoor and outdoor applications.—R. E. Uptegraff Mfg. Co., Scottdale, Pa.
Circle 679 on inquiry card.

Metal Nameplates. New 4-page illustrated bulletin describes maker's new "Speedy-Cals" self-adhesive metal nameplates.—North Shore Nameplate Co., Glenwood Landing, L. I., N. Y.
Circle 680 on inquiry card.

Nameplates. New 6-page illustrated Bulletin N54 presents description of maker's nameplates and information for determining specifications.—Croname Inc., 3701 Ravenswood Ave., Chicago, Ill.
Circle 681 on inquiry card.

Capacitors. New 4-page Bulletin 109 describes maker's a-c. electrolytic capacitors in molded plastic cases for motor starting and other intermittent duties.—Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Circle 682 on inquiry card.

POWER SUPPLIES

Electronic Voltage Standards. New 2-page brochure describes maker's new "Model VRS15" d-c. voltage standard and "Model VRS-AC10" for a-c. calibration of meters and oscilloscopes.—Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.
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Power Supplies. New 2-page Bulletin B-208 describes and illustrates maker's regulated d-c. power supplies.—Millivac Instrument Corp., P.O. Box 997, Schenectady, N. Y.
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Mercury Cells. New 6-page Brochure 1-8 illustrates and describes maker's mercury cells and batteries for applications involving limited space and extremes in operating conditions.—

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P. R. Mallory & Co. Inc., N. Tarrytown, N. Y.

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Frequency, Voltage Regulators. New 4-page Bulletin 1061 describes and illustrates maker's precision frequency and voltage regulators for aircraft inverters.—W. L. Maxson Corp., 460 West 34th St., New York, N. Y.

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Power Supply. New 2-page bulletin presents specifications and applications of maker's "Model 2" 300-v. d-c. regulated power supply.—Eastgap Co., 285 Columbus Ave., Boston, Mass.

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TUBING

Titanium Tubing. New 8-page Bulletin 42 presents properties, applications, processing and fabricating characteristics of maker's line of titanium tubing.—Superior Tube Co., Norristown, Pa.

Circle 688 on inquiry card.

Tube Fittings. New 2-page Bulletins L-9335 and L-9306 describe and present installation instructions for maker's line of tube fittings in brass, aluminum, steel and 316 stainless.—Dekoron Products Div., Samuel Moore & Co., Mantua, Ohio.

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Quick-seal Couplings. New 16-page catalog describes and illustrates maker's line of quick-seal hose couplings.—Titaflex, Inc., Hendee St., Springfield, Mass.

Circle 690 on inquiry card.

Tubing Tools. New 20-page Catalog 3011-A presents maker's line of tube-working tools. Includes tools for cutting, flaring, bending, reaming, swedging, pinch-off, and refacing.—Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.

Circle 691 on inquiry card.

Hose Assemblies. New 4-page brochure describes and illustrates maker's line of high-pressure hydraulic hose assemblies.—Couse & Bolten Co., 42 Lafayette St., Newark 2, N. J.

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EQUIPMENT, FABRICATION

Miniature Bearings. New set of bulletins present specifications on maker's beryllium and flanged shielded bearings and details on two new miniature bearing applications.—Miniature Precision Bearings Inc., Keene, N. H.

Circle 693 on inquiry card.

Marking Machines. New set of bulletins (11A, 11T, and T) describe and illustrate maker's line of marking machines for marking, numbering and stamping metallic parts.—Acromark Co., 9-13 Morrell St., Elizabeth, N. J.

Circle 694 on inquiry card.

Lathes, Drill Presses. New 56-page Catalog 5406 describes and illustrates maker's line of lathes, drill presses, shapers, and pedestal grinders.—South Bend Lathe Works, 425 E. Madison St., South Bend, Ind.

Circle 695 on inquiry card.

Pivot Burnishing Machines. New 30-page booklet describes and illustrates distributor's line of pivot-burnishing machines and accessories.—Carl Hirschmann Co., 30 Park Ave., Manhasset, N. Y.

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Compressors. New 4-page Bulletin 212-A and 6-page Bulletin 600 illustrate and describe maker's "Oilfreair" and "Oilfregas" compressors for instrument air.—Pennsylvania Pump and Compressor Co., Easton, Pa.

Circle 697 on inquiry card.

Drilling Machine. New 4-page illustrated brochure presents description, diagram and photographs of maker's "Model R-53" drilling machine.—High Speed Hammer Co., Inc., 313 Norton St., Rochester, N. Y.

Circle 698 on inquiry card.

Taping Machine, Armature Winder. New 6-page folder describes and illustrates distributor's "Froitheim & Rudert" automatic armature-winding machine and automatic taping machine.—Rex Rheostat Co., 3 Foxhurst Rd., Baldwin L. I., N. Y.

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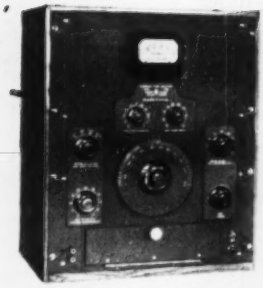

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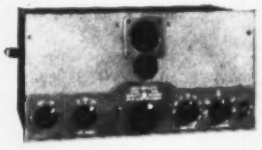

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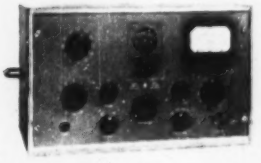

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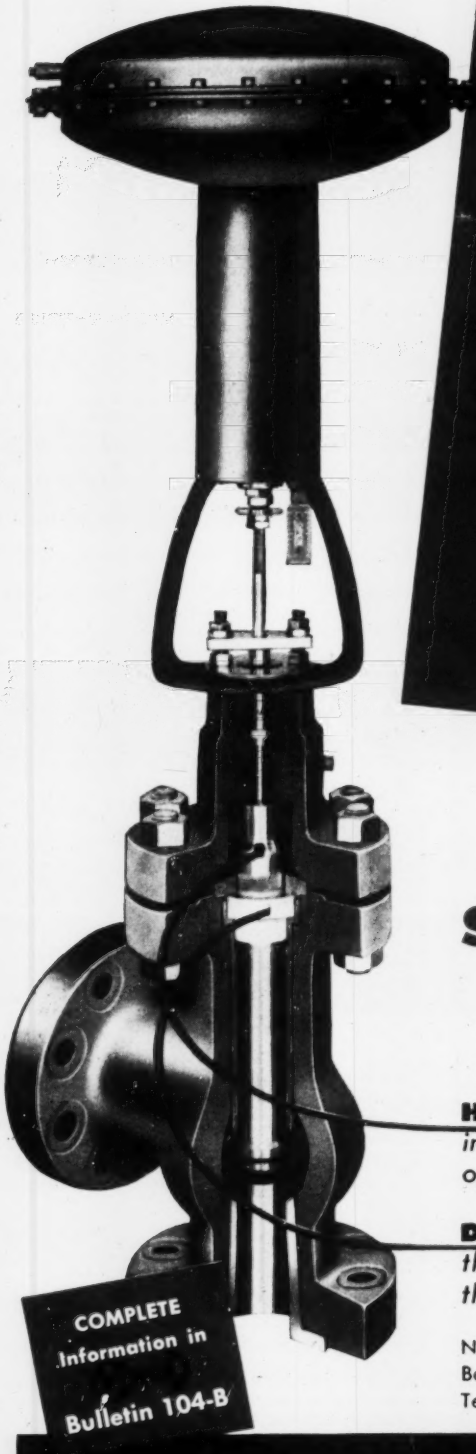

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